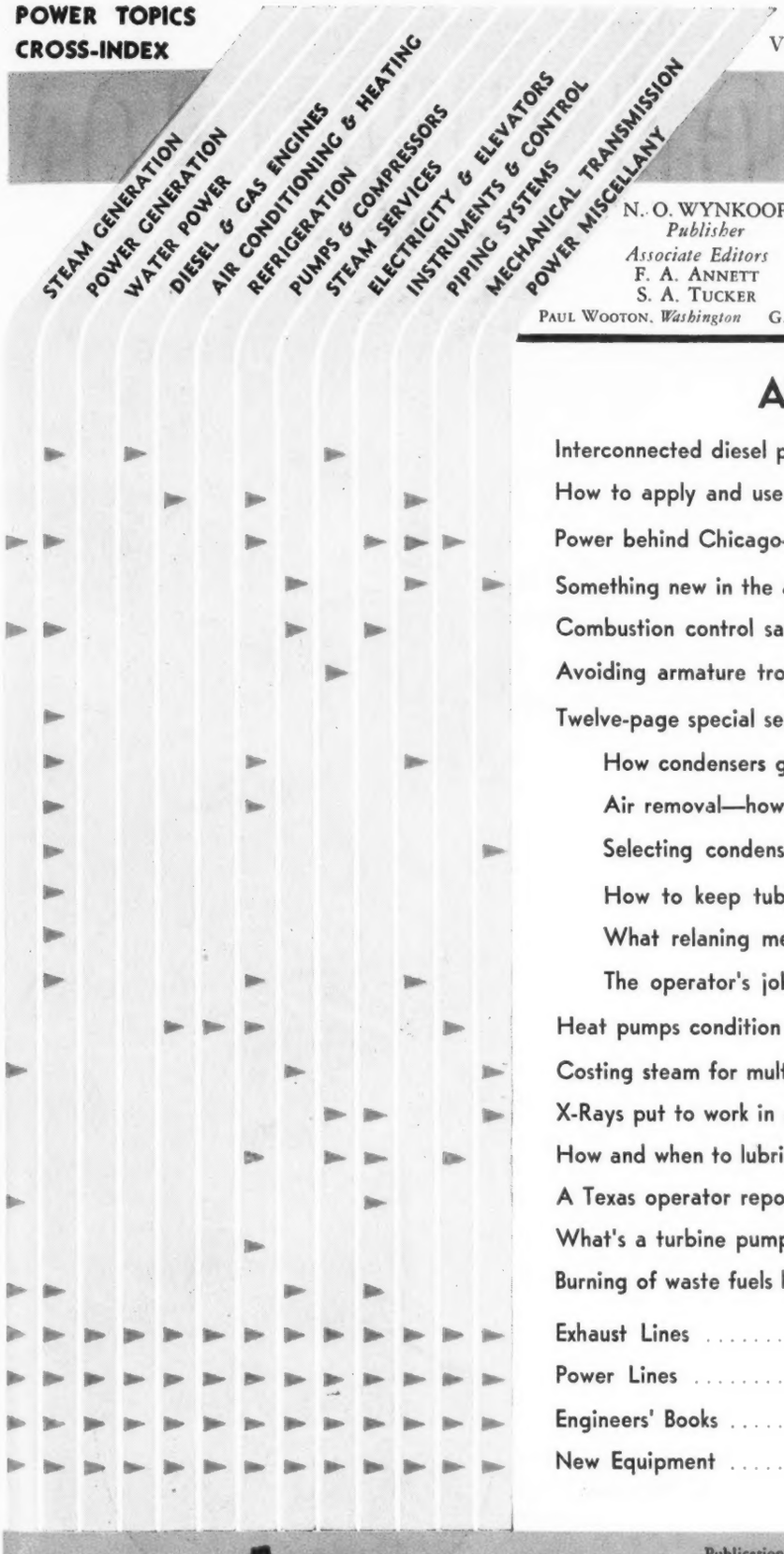
POWER TOPICS CROSS-INDEX

VOLUME 83 NUMBER 4

POWER



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APRIL, 1939

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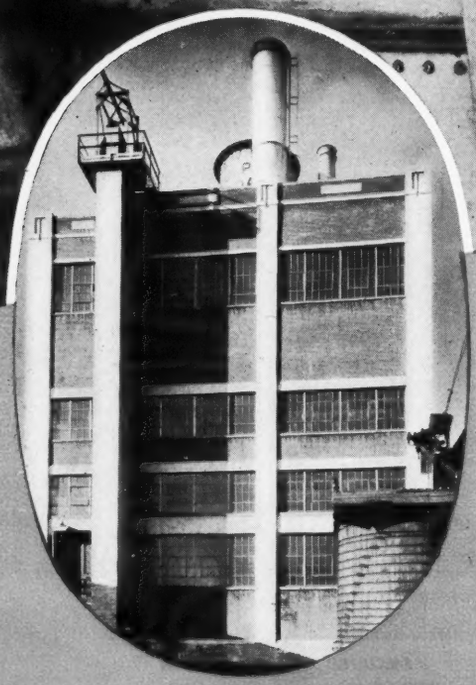
FUEL CONSUMPTION



Link-Grate Stoker firing 980-hp. boiler in plant of New Haven Pulp and Board Company, New Haven, Conn. — the second stoker installation in this plant.

Westinghouse

POWER

Established 1882 PHILIP W SWAIN, Editor

Just a Mechanic

Somewhere back in the dim past some one coined the expression "a mere mechanic"—a mean little title. The words have twisted much thinking.

In ruffly Versailles, before the French Revolution, the lily-fingered dandies had a name for the fellows who knew how to be useful. In Victoria's England the nobility looked down on the untitled "gentlemen". These snubbed the tradesmen and the tradesmen snubbed the mechanics.

America's founding fathers couldn't be so superior; they had to sweat out a living with their hands or starve. But history repeats, and thrice-removed Sons rose again to the estate of those who can afford to glorify the clumsy hand. They rediscovered two orders of beings: on the one hand the "brain workers"; at the other extreme the men who "work with their hands and not their heads", it being understood by all educated persons that the skill of the hand resides in the knuckles and wrist and not in the cranium.

This comforting idea took firm hold of all well-born fathers and mothers of Victorian New York, Boston and other points East. The South was suffocated with it. The West did not yield so early to this poisonous doctrine; the shades of pioneer ancestors were still hanging around.

Right now the "mere mechanic" concept is slipping. Good riddance to a lot of silly nonsense!

In spite of the machine (or rather because of it), America's crying need today is for truly skilled all-round mechanics—men able to build, install, adjust and maintain the productive equipment in our so-called "manless" factories. Long since, the machine ceased displacing skill. It now insistently demands more skill.

The alert boy getting out of high school this year could do far worse than nurse an ambition to become a mechanic—not a six-weeks graduate of a learn-quick specialty school, but a real mechanic at ease with file, scraper, micrometer and surface gauge, with drills, taps and dies, with soldering iron, torch and tin snips, with lathe, grinder and planer.

Four years in the right place will have him on his way and then a thousand industries will welcome his sure hand and keen eye. He will always be ten steps ahead of the fellow who took the short cut, the fellow who studied to be an aviation mechanic without learning how to handle tools, the fellow who thought he could go places as a power engineer by operating his mind in a mechanical vacuum.

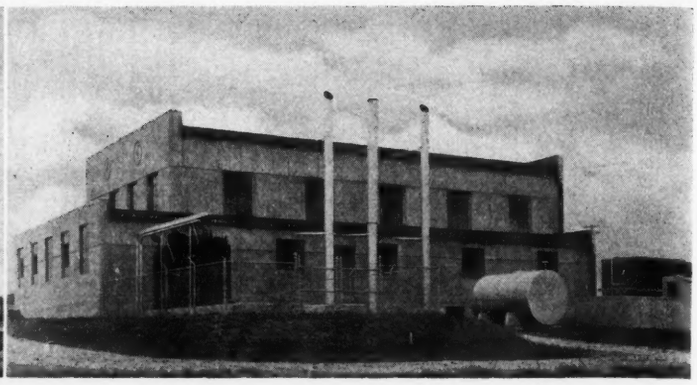
By now, my views should be clear to all. I consider mechanical skill, and the sound intuitions it gives one, the cornerstone of all engineering, "the stone which the builders have forgotten"—some of them.

"Why all the shouting? Don't all engineers recognize these facts?" Not all, I'm sorry to say. A certain school of "professionals" is growing up whose self esteem is lightly grounded. They live in daily fear that some uninformed person may confuse them with "mechanics". God knows why; they should feel honored by the suspicion and hasten to prove it true, if they can. Instead, they say they want to be classed with the lawyers.

In the next breath they hope to be classed with the surgeons. That makes sense, for the real surgeon is the prince of mechanics. He can reach his hand in and splice tubes at 98 F, so he rates as one of the Brothers.

I covet for all American engineers the self reliance and the power of achievement that comes only from the right underpinning. Be as theoretical as you wish; explore mathematics to your heart's content; learn the arts of writing and after-dinner speaking if you will, but be always a mechanic if you would call yourself an engineer.—*Phil Swain*

Plant of Central Electric Federated Cooperative Assn near Pocahontas, Iowa. Fuel-oil tank and water sump at left



Plant of Federated Cooperative Power Assn, south of Hampton. Rear view shows exhausts, centrifuged-fuel tank, cooling tower

Diesel Power for Iowa Farms

By C M STANLEY
Young & Stanley, Inc, Engineers, Muscatine, Iowa

Interconnection between two REA diesel plants, of similar design, cuts investment, increases operating flexibility. Stations follow best modern practice with reinforced concrete buildings, metal-clad switchgear, and complete metering

TWO COOPERATIVELY owned and operated diesel generating plants now provide electrical energy to a considerable area in the rich agricultural district of north central Iowa. These two plants, financed by the Rural Electrification Administration, are part of the program of bringing electric service to the farmers of this area.

Although having similar origin and history, the plants differ considerably in type and make of equipment installed. Features include arrangement for inter-connection between the two plants; use of metal-clad switchgear; use of monolithic concrete buildings; and provision for complete metering records within the plants. Each station is owned and operated by a cooperative association whose membership is made up of several county cooperative associations, each of which distributes electrical energy to the rural customers within its area.

One of the plants, belonging to the Federated Cooperative Power Association, is about 4 miles south of Hampton, Iowa, while the other plant, belonging to the Central Electric Federated Cooperative Association, is 1 mile southeast of Pocahontas, Iowa. Approximate location of the plants, and the area served by them, is shown on the map. Some 70 miles separate the two stations.

The inter-connecting line between the two plants, and the main feeders into the area served, are all 7200/12,500 volt "Y" lines with grounded neutrals. It is expected that each plant will ultimately serve nearly 3000 miles of line, which will accommodate between 8000 and 8500 customers, developing peak load of about 2750 kw.

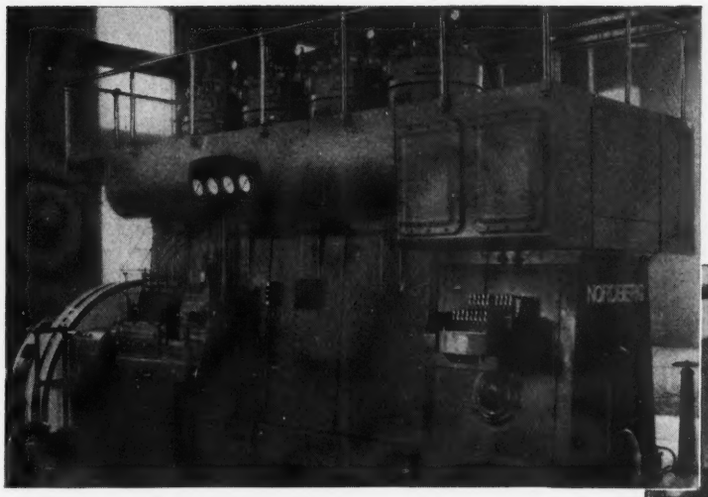
Reason for Diesels

Diesel-generating equipment was selected for each of the plants because of apparent economy in first cost and operating cost for plants of the size required, serving rural loads of relatively low load factor. The extreme flexibility of a diesel plant offers advantages, not only in permitting combination of generating units in operation in order to follow swings in load, but also in facilitating step-by-step construction to follow increases in load.

While the two plants differ in many details, they are similar in fundamental design. Each is in the country outside the corporate limits of the nearby town or city, and has a railroad siding for unloading construction materials, as well as fuel oil. Location outside city limits avoids municipal taxes and facilitates arrangement of outgoing feeder lines.

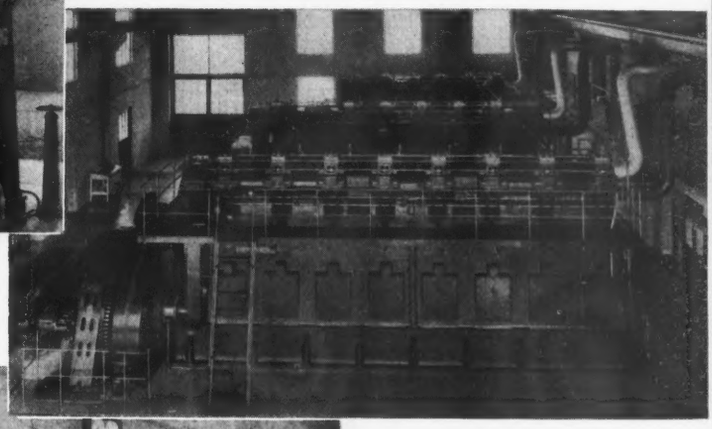
Each site provides space for power plant, oil-storage tanks, cooling tower, and the superintendent's residence. Each plant will accommodate an ultimate installation of 4750 hp of engine capacity.

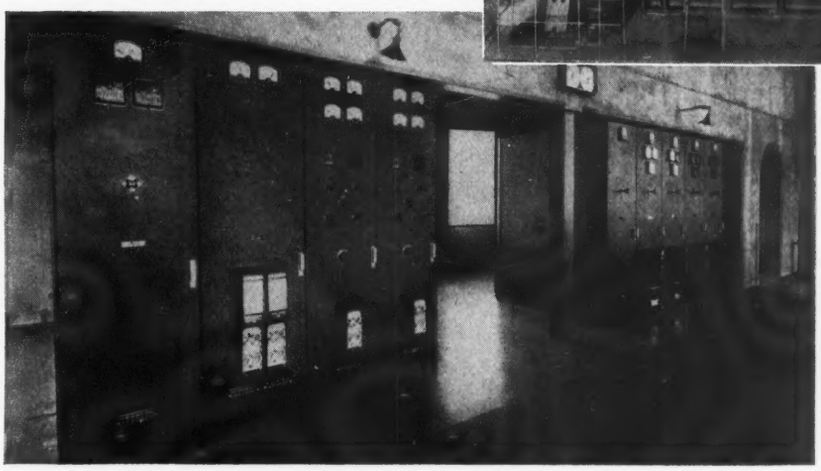
The Federated plant, near Hampton, has an initial installation of two Nordberg, 2-cycle, 257-rpm engines, driving Elliott generators. One is a 4-cyl unit rated at 1000 hp, 700 kw, while the other is a 3-cyl unit rated at 750 hp, 525 kw. Arrangements have been completed for installation this year of a 6-cyl, 1500-hp, 1050-kw unit of the



Closeup of 1000-hp engine at Federated plant

Engine room at Central plant houses two 1000-hp and one 750-hp units





Switchgear at Federated plant: 2400-volt equipment at left, 12,500-volt at right

same design and type. The building has sufficient space to permit future installation of another 1500-hp unit, which will bring total capacity to 4750 hp, or 3325 kw.

The Central plant, near Pocahontas, has an initial installation of three Fulton Iron Works Co, 4-cycle, 225-rpm engines, driving Electric Machinery Mfg Co generators. Two of the units are 8-cyl, 1000-hp engines with 700-kw generators, and the third unit is a 6-cyl, 750-hp engine with a 525-kw generator. Space is provided in the building for two additional 1000-hp units, which will bring ultimate capacity to 4750 hp, or 3325 kw.

Accessories

Both plants have conventional accessories, including a closed cooling-water system with atmospheric cooling towers, raw- and jacket-water circulating pumps, lubricating-oil transfer pumps and centrifuges, fuel-oil pumps and centrifuges, air compressors and air tanks. Each plant has a 50,000-gal steel storage tank for fuel oil and arrangements have been completed for installation of an additional storage tank of the same capacity.

Water supplies were developed on both sites by drilling wells and providing necessary pumping equipment and storage tanks. Extremely hard water was encountered in each case, and although softeners have been provided for jacket water, arrangements are now being made to treat cooling water used in towers.

Waste-heat boilers, connected to a steam-heating system, heat the power plants, supplemented by an oil-fired boiler for use when load is not heavy enough to produce sufficient steam.

Plants generate at 2400 volts, 3 phase, 60 cycles. All generators connect to a 2400-volt bus in the station switchgear from which cables run to three 500-kva step-up transformers which raise the voltage to the line voltage. High-voltage side of the transformers connects to a 12,500-volt switchgear unit in the plant which controls each of the outgoing feeders.

There is considerable difference in the arrangement of the auxiliary equipment in the two plants. Federated has all auxiliary equipment in the basement. Space on the first floor provides for washroom, tool room, store room, office, and switchgear. At Central, most auxiliary equipment is on the first floor, with only a few items in the basement. Waste-heat boiler, oil-storage tanks, oil filters, and other equipment are all on the mezzanine, or balcony.

Interconnection

Provisions for inter-connecting the two generating plants introduced a number of factors not usually encountered in REA generating plants. While the line inter-connecting the plants is not fundamentally a transmission line, but rather a distribution line serving customers along its entire length, nevertheless, it has sufficient capacity to permit shifting of blocks of load between the two plants. Under normal operating conditions, an air break switch at the Wright-Humboldt County line is open, and each of the plants

carries the load from its own area. However, there is metering equipment at the switch point so that whenever necessary, the switch can be closed, the two plants operated in parallel, and load interchanged and metered. Care in design of generating equipment insured satisfactory paralleling characteristics of engines in the two plants.

The Federated plant was completed and placed in operation several months ahead of the Central plant. As soon as lines in Central area were ready to receive electrical energy, these lines were energized and served from Federated station. In addition to this service, inter-connecting lines permit two definite economies. In the first place, they make available a certain amount of emergency service in case of trouble in either plant. Another advantage is that with the inter-connecting line and the emergency service mentioned above, it is possible to stagger the extensions to the two plants by utilizing the transmission line to make excess reserve capacity available in the larger of the plants at any given time. This will result in economies of fixed charges on equipment that must be added from time to time to keep step with load increase.

In design, every effort was made to provide equipment that would be as reliable and foolproof as possible, as it was desired to operate the plant with only one man per shift. For this reason, simplicity and reliability were given considerable emphasis. Studies were made on a number of arrangements of switchgear and substations, including outdoor units.

It was finally decided to place all switchgear within the plant to make it convenient for the operator, and to place only step-up transformers outside. This required use of a 2400-volt switchgear unit and also a 12,500-volt switchgear unit. The low-voltage unit controls all of the generator circuits, while the high-voltage unit controls the outgoing feeders. Both of these switchgear units are metal-clad with vertical-lift, removable oil circuit breakers. This type of equipment was selected because of its reliability and safety features. A spare removable breaker unit can replace any of the breakers in case of failure or trouble.

Building Construction

A feature of these plants is use of monolithic architectural concrete for superstructures. As noted in the photograph, this type of construction has given a simple, yet pleasing, architectural treatment in keeping with the general spirit of design. Concrete poured into forms and reinforced to take care of shrinkage and temperature stresses forms the wall. The architectural treatment was obtained by placing inserts, or bowls, within the forms. Although these were among the first monolithic concrete structures built in Iowa, the results have been exceedingly gratifying.

Cost estimates indicate that this type of construction provides superior architectural treatment at less than could be obtained with a conventional, steel-frame, brick-wall building.

Careful attention to provision of adequate metering equipment throughout the plant permits keeping careful and accurate records which will give a true indication of operating cost.

As fuel oil comes into the plant from the oil-storage tanks, it is metered so that total consumption of oil can be obtained. Additional meters measure fuel-oil consumption of each engine, and of the auxiliary oil burners used as part of the heating system, thus permitting a complete accounting of all oil received in the plant. Lubricating-oil consumption of each engine is metered and also return of oil after centrifuging is checked. In this manner, complete and accurate figures on lubricating oil can be obtained.

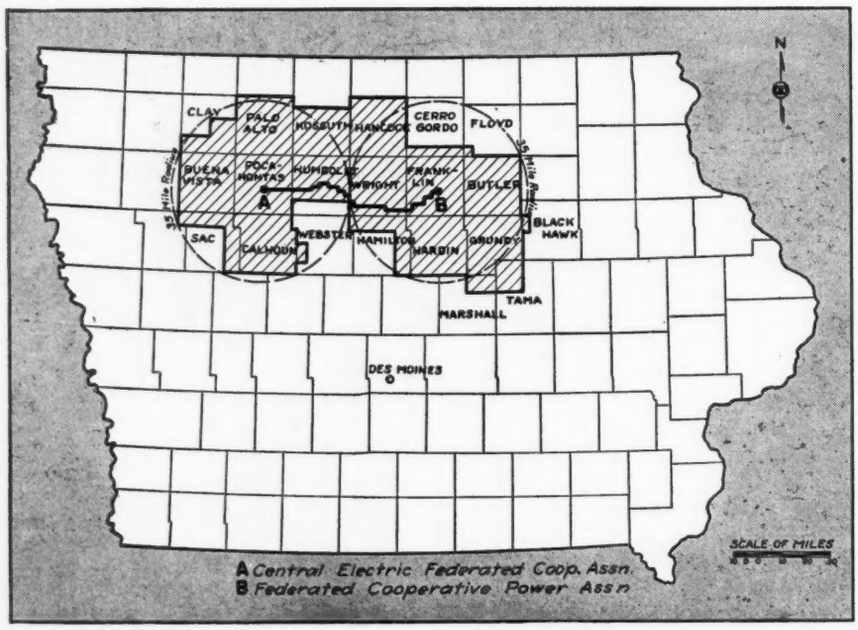
Output of each generator and the consumption for station power and for station lighting is metered as well as the amount of energy delivered to each of the feeders. Sufficient thermometers, pyrometers, and similar indicating equipment permit keeping careful records and checking of operation on all essential points of the generating equipment. Log sheets permit keeping complete and accurate records.

Operating Personnel

A superintendent and three operators man each plant. The superintendent has complete charge of the plant, reporting to the Board of Directors of the Cooperative Association, and has no duties beyond the generating plant; his job is to deliver electrical energy to outgoing feeder lines at lowest possible cost. Arrangements have been made to construct residences for the superintendents at the sites of each of the plants, so they may be on hand at all times.

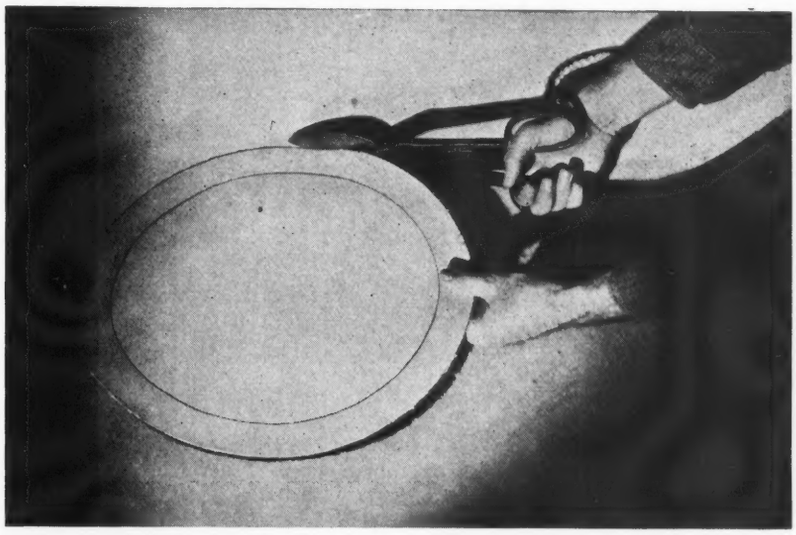
Loads on both plants have been growing rapidly. A maximum demand of over 900 kw has already been carried on the Federated plant, while the maximum load on the Central plant has been around 600 kw. With completion of additional lines now under construction in the area served by these plants, loads are expected to increase further. The plants have been in operation too short a time to determine definitely what the operating costs will be. However, both of these plants are making a fine showing in spite of the undeveloped loads and are obtaining around 12 kwhr per gal. of fuel oil, which figure will unquestionably get considerably better as the load becomes stabilized.

Mr. Arthur Oliphant is superintendent of the Federated plant and Mr. Raymond B Dobbs of the Central plant. Young & Stanley, Inc, were engineers on both projects. The work was carried out under the supervision of the writer.



Location of plants and area served

Pointers on Asbestos Gaskets



Knowing how asbestos sheet gasketing is made and how to apply it properly means fewer troublesome joints in power-plant piping

By F E DAVENPORT
Crane Co

MAKING A TIGHT JOINT between two flange faces requires a gasket material that will, under correct compression, mold itself to the two faces and resist leakage.

Asbestos sheet packing, one of many gasket materials familiar to the power engineer, is made of selected long-fibre asbestos compressed into sheet form and held by a binder containing pure rubber and a suitable mineral filler. Chemical specifications call for a minimum of 80% long-fibre chrysotile asbestos, containing not less than 12% water of crystallization. This water, a natural part of raw asbestos, adds life and resiliency to the fibres; without it, they would be brittle and dead. Percentage of water of crystallization vitally affects service of the finished packing, so Canadian asbestos, with percentages ranging from 12-14, is used.

Physical specifications call for an average tensile strength of 4,500 lb per sq in. in all directions of stress, and a minimum compression resistance of 48,000 lb per sq in. In manufacture, loose fibres are formed into sheets from 1/64-in. to ¼-in. thick. Right-angle cross laminating two sheets of equal thickness produces the desired thickness of finished packing. Sheets are then impregnated with binder and permanently bound together under compression.

Today, good quality sheet packing is recommended for a total bolt load of 30,000 lb per sq in. but must withstand a test of 48,000 lb to give an ample factor of safety. Experience shows that such a sheet packing may be successfully used on valves for high-pressure saturated or super-heated steam, provided maximum temperature does not exceed 750 F. A packing that can handle those conditions can handle other severe services such as acids, alkalis, oils, gasoline, gas, dry air, and ammonia. However, caution is urged in the use of any compressed fibre or soft gasket in flanged joints on high-pressure hazardous-liquid service, unless such a gasket is protected to prevent blowout, as in a male-and-female, or tongue-and-groove joint.

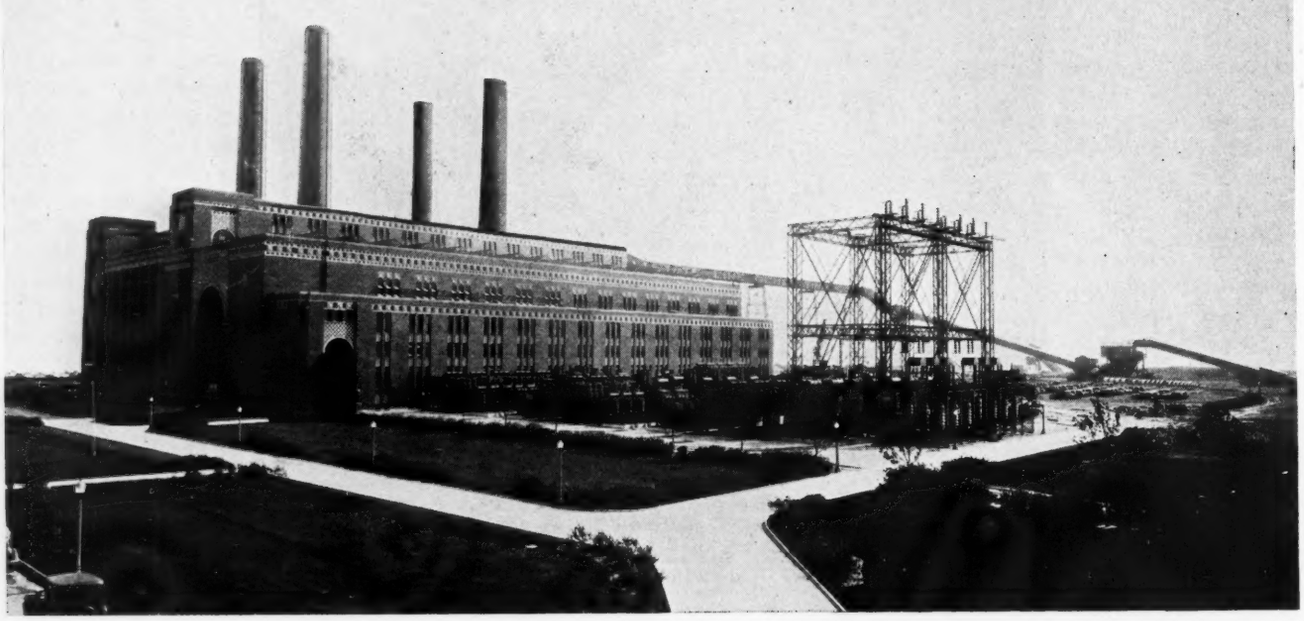
In applying any sheet-gasket material, success or failure depends on properly applied compression stress. Bolting of adequate strength, properly applied; kind of flanges and their facings; and periodic inspection of bolt loading are important factors in satisfactory performance.

Gasket width should be proportioned so that compression load will be at least 5,000 lb per sq in. It is a common mistake to use a gasket too wide to permit proper compression.

Kind of bolting used for a joint is important; common bolt steels usually have a yield point of approximately 30,000 lb per sq in. On smaller sizes, particularly 1-in. or less, it is a simple matter to stretch the bolts beyond their yield point with an ordinary wrench commonly used by steam fitters. The resulting permanent set releases compression load from the gasket. In high-temperature service, bolting material will continue to stretch after the initial tensile stress is applied. Thus it is necessary to use bolts which have higher physical properties at elevated temperatures, or to follow up bolting periodically to maintain proper gasket compression.

Light-weight or brass flanges are readily distorted when improperly bolted up. Any overload of bolting will cause flange faces to ride on the outer circumference of a ring gasket, producing inadequate contact with the gasket. Wide or full-face gaskets will minimize this tendency. On the other hand, a much narrower gasket may be used with flanges and bolting of proper size, and will make a better joint because the amount of gasket compression varies with the proportion of bolt load to effective gasket area. In making up a tight joint, it is advisable to coat gaskets with a suitable lubricant.

Power Behind Chicago



State Line Generating Station's second unit, in operation over a year, is a 150,000-kw, 1200-lb reheat plant with the world's largest hydrogen-cooled generator and one 3000-gpm reciprocating boiler-feed pump. Performance of Unit 2, close to 11,000 Btu per kwhr, is 15% better than 208,000-kw unit

WHEN State Line Generating Station first began to supply power to the Chicago Metropolitan district in 1929, its 208,000-kw double cross-compound (three-generator) unit was, and still is today, the largest electrical production unit anywhere in the world. The second unit, placed in commercial operation January 1, 1938, is a 150,000-kw, 3-cylinder, tandem-compound unit (one generator) served by three boilers at 1200 lb, 825 F.

Primarily a producer of wholesale power, the station serves an extensive interconnected system. Large generating units are in keeping with power needs.

The first unit operates at 650 lb, 730 F, with steam reheat to 485 F at about 100 lb pressure. Unit No. 2 takes steam at 1200 lb, 825 F and employs a flue-gas reheat cycle, one boiler reheating 1,063,000 lb of steam per hour to about 800 F.

This increase of pressure and change from steam-reheat to flue-gas reheat cycle are principal factors in the better operating efficiency of the new unit over the earlier larger machine, for which a direct comparison can now be made based on over a year of operation. The first unit has a heat rate of about 13,000 Btu per kwhr and No. 2 shows a performance close to 11,000 Btu per net kwhr.

Unit 2 was purchased in November, 1929 and was originally scheduled for operation early in 1932, but load conditions which prevailed during the depression resulted in postponing completion of the installation several years. In the meantime, turbine and generator (which had been shipped and partly erected) were protected by enclosures and warm dry air was continually circulated through the generator. These measures were later found to have been entirely effective in preventing deterioration of the equipment.

The general heat-balance arrangement was carried out essentially as originally planned. Three boilers were installed for Unit 2.

Noteworthy is the application of hydrogen cooling to the 150,000-kw generator. This generator is nearly three times the capacity of any other now running in hydrogen and demonstrates the practicability of hydrogen cooling large 1800-rpm machines as well as 3600-rpm generators from 25,000 to 50,000 kw.

The change from air to hydrogen cooling required building a new gas-tight casing strong enough to withstand possible explosion pressure. Redesign of generator bearings, new hydrogen coolers and external motor-driven fans totally enclosed in the hydrogen circulating system were features of the generator reconstruction. Fans on the generator shaft, as usually installed, were impractiable because of lack of space on the rotor, which had already been built.

The change from air to hydrogen cooling increased the generating capacity of the unit at 85% power factor from 132,000 kw to 150,000 kw. Hydrogen cooling has also reduced gen-

erator windage losses by about 900 kw which of course, is a direct saving at all loads.

The only difficulty of any importance so far experienced in connection with the hydrogen-cooling system is one which might be expected in any large-scale application of a new method of generator cooling. The external fans did not, at first, develop sufficient capacity for circulating hydrogen to the extent necessary to permit full rating on the generator. Larger fan wheels were installed, and later the fan speed was increased by interposing a 60-cycle to 80-cycle frequency changer in the power circuit to the fans. At 2400-rpm fan speed, full generator capacity of 176,000 kva can be carried, that is, 150,000 kw at 85% power factor. The circuits are so arranged, however, that the fans can still operate at 1800 rpm from 60-cycle power in event of failure of the frequency changer. The load limit with this arrangement, however, is 150,000 kw at 90% power factor.

The hydrogen-cooling system is equipped with apparatus for removing entrained hydrogen from the shaft-sealing oil. This equipment has operated satisfactorily, as have the various alarms and controls. Hydrogen leakage is less than one bottle (200 cu ft) per day.

Turbine-room layout follows the general lines of Unit 1 with a minimum of flooring at the turbine level.

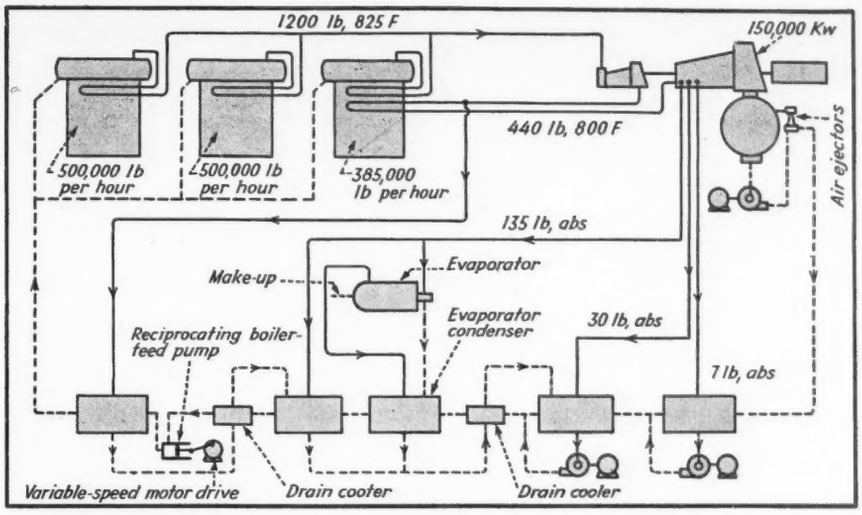


Fig. 1—Flue-gas reheat cycle for Unit 2, 1200-lb steam pressure and 4-stage feedwater heating account for performance about 2000 Btu per kwhr better than Unit 1

Practically all operation is carried on at the basement-floor level where are located auxiliary equipment, meters and controls. This is made possible by the vertical condenser arrangement. Large circulating-water piping is practically eliminated from the turbine room by placing pumps in a separate screen house outside the plant.

This disposition of equipment saves time and expense in maintenance and overhauling operations by permitting use of the turbine-room crane for handling practically all heavy equipment parts. Experience to date has proved the value of the layout from an operating standpoint.

A contrast is afforded between the condenser arrangements of Units 1 and 2. Advances in generator design permitted developing full capacity of Unit 2 with a single generator and consequently only a single low-pressure turbine casing, which, as can be noted in Fig. 3, opens to a 45,000-sq-ft single-pass condenser on either side. Unit 1, having two low-pressure turbine elements, exhausts to eight vertical condensers.

The horizontal reciprocating boiler-feed pump, shown in Fig. 4, is the

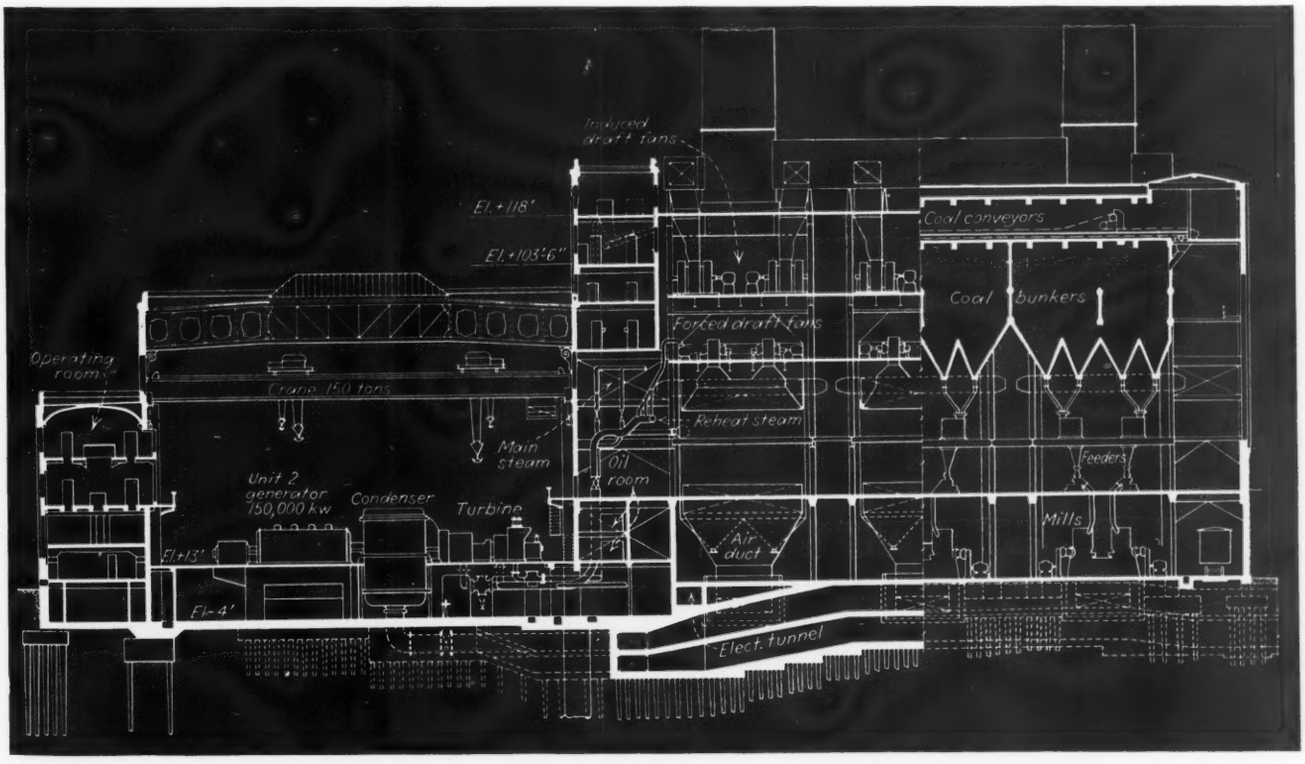


Fig. 2—One reheat and two standard boilers supply new unit. Vertical condensers permit operating practically all turbine-room equipment from basement floor

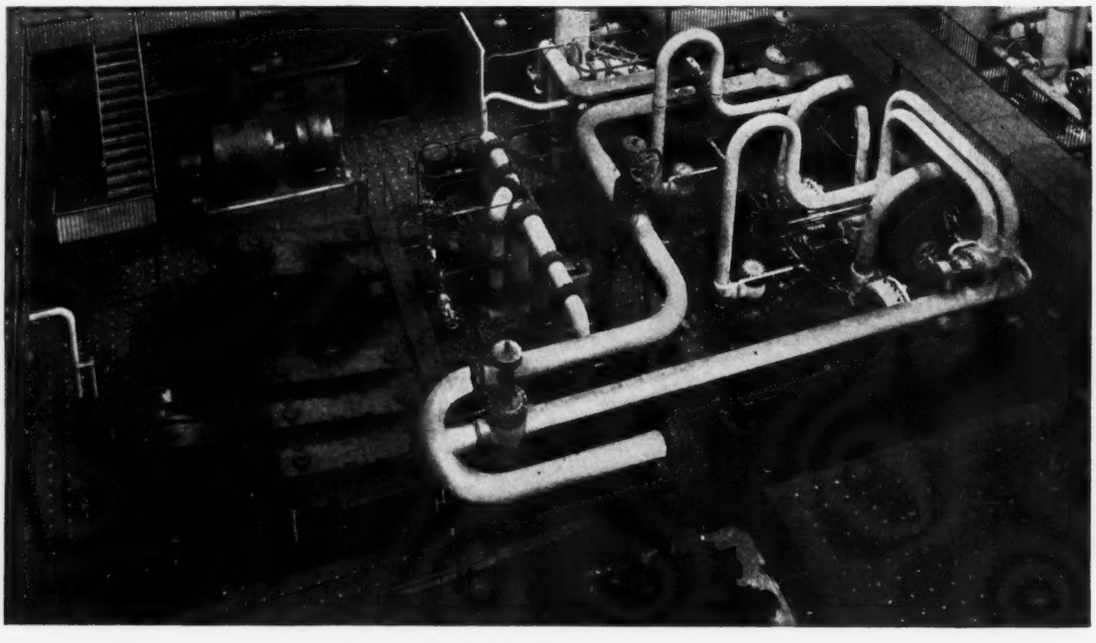
Fig. 3—View of turbine room with new unit (hydrogen-cooled generator in the foreground) gives an idea of ample space allowance for operation and maintenance. Turbine-room crane can service all heavy equipment

only unit of its type in high-pressure central-station service. The 5-cylinder single-acting pump, of 3000 gpm capacity, operates with feedwater at 330 F from a suction pressure of 225 lb to a maximum discharge pressure of 1600 lb.

The pump is driven by a special variable-speed control, an arrangement of ac and dc motors on one shaft, which affords a speed range from 282 to 708 rpm. A 1750-hp induction motor furnishes the base speed and a 750-hp dc motor supplies speed variation. A 12-to-1 reduction gear drives the pump crankshaft. Speed is regulated by an impulse from the automatic feedwater-control system to supply increasingly higher feedwater pressure as boiler load increases.

While this pump construction is massive and occupies considerable floor space, efficiency is considerably higher than centrifugal pumps for the same service and this high efficiency is maintained over the load range. Since feed-pump power is an important item in high-pressure plant auxiliary use, a material saving is effected. Except for minor readjustments and packing rearrangement, operation has been entirely satisfactory including drive and control mechanisms. Two 1500-gpm centrifugal pumps furnish standby, each driven by a 1200-lb steam turbine.

Fig. 4—The 3000-gpm, 5-cylinder, horizontal-reciprocating boiler-feed pump has a variable speed motor drive. Turbine-driven centrifugal pumps for standby are at right



Feedwater heaters are disposed vertically near the head end of the turbine. The 4 feedwater heaters, drain coolers and evaporator system are easily accessible to the crane.

Original piping designs called for flanged joints in the high-pressure piping. Here again, advantage was taken of advances in welding technique made between 1930 and 1936, to use carbon-moly steel pipe with welded joints. Reheat piping passes beneath the turbine-room floor and does not appear in Fig. 3.

Live steam reheaters were not used because of the high reheat temperature, 825 F, required for the new unit. The increase in initial steam pressure from 650 lb for Unit 1 to 1200 lb for Unit 2 and the change from live-steam reheat to flue-gas reheat are largely responsible for the 15% improvement in heat-rate performance of Unit 2 over Unit 1.

The new unit operates practically as a separate power plant because of the increased steam pressure over Unit 1. Two 500,000-lb-per-hr boilers and one reheat unit supply the turbine. Each has a 31,000-sq-ft steaming economizer and 79,750-sq-ft tubular air preheater. The reheat boiler is of the same heat-output capacity as each of the two standard boilers, that is, about 350,000 lb of steam per hr when reheating 1,063,000 lb from 700 to 800 F at 450 lb.

A limited supply of natural gas is available and the boilers are equipped to burn gas or pulverized coal or a combination of both fuels when required. Normally, about half the fuel requirements are supplied by gas. After an extended period of investigation by actual operation of boilers with varying amounts of excess air when burning gas, best efficiency is obtained in normal operation with about 15% excess air.

Furnaces have slag bottoms arranged for continuous discharge into water-filled storage tanks. This "continuous slag tap" was first developed for Unit 1.

Engineering design for Unit 2, as for Unit 1, is by Sargent and Lundy, Chicago.

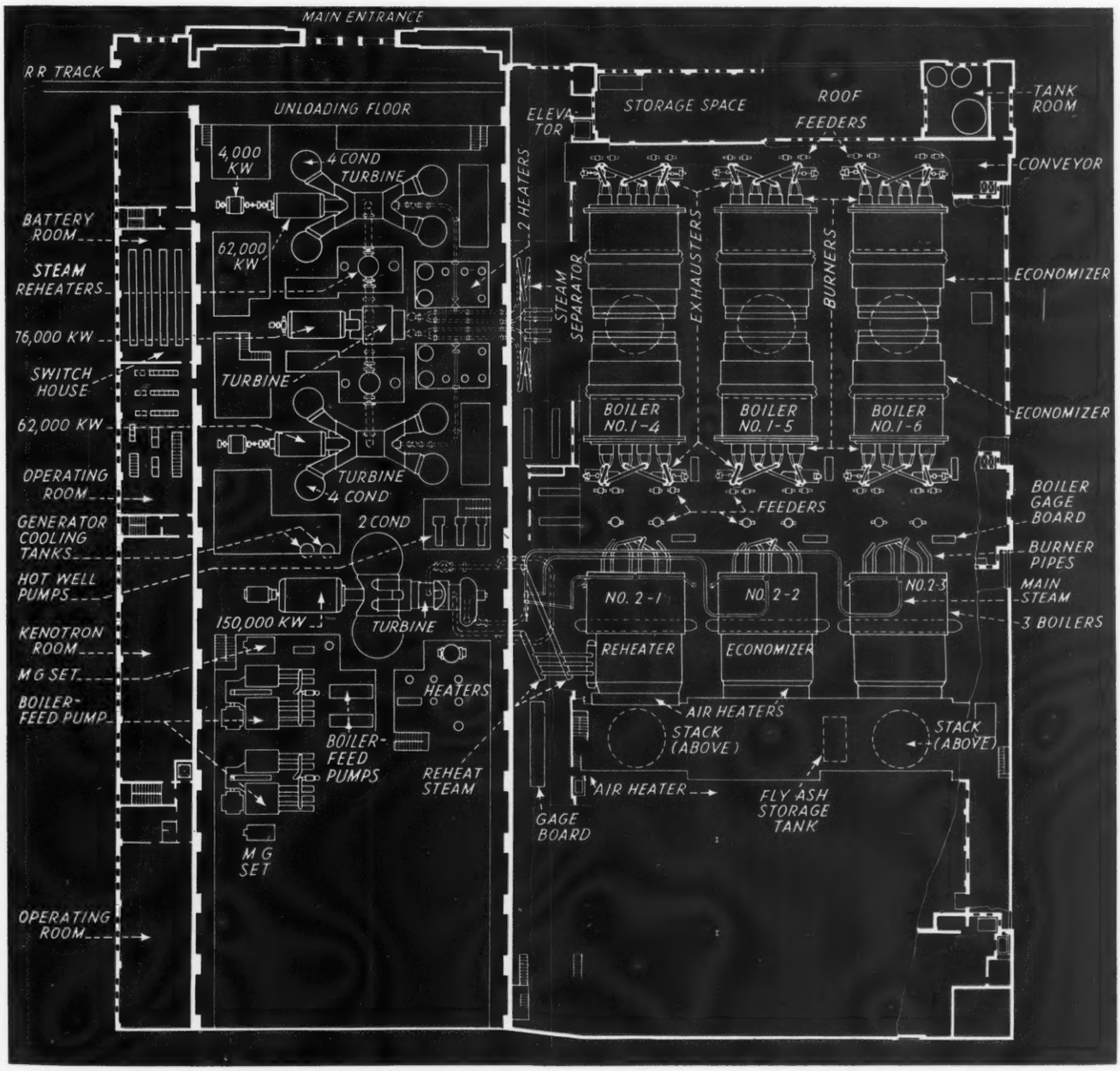


Fig. 5—Plan of station shows relation of 150,000-kw tandem Unit 2 to double cross-compound 208,000-kw Unit 1. Building extension provides for third unit

Something New in Metal Spray

By JAMES W GIBBONS
Metal Spray Engineer,
American Sugar Refining Co,
Brooklyn, N. Y.

Plastics, hard rubber and other materials can now be sprayed in fighting corrosion. User can also specify his own metallic alloys

THERE HAVE BEEN many recent improvements in metal spraying, mostly in application and construction of the wire pistol or gun. Speeds have been jacked up, wire sizes increased, but today's streamlined job is essentially the same as yesterday's wire pistol. Now gears are all totally enclosed, running on ball bearings in an oil bath, the propelling turbine has been enlarged, feed rollers made adjustable, etc, but the principle and the resulting coating are the same.

And now, this country is seeing a powder pistol, introduced here 14 months ago. This gun, brought out in England about 1933 by Schori, has been gaining wide acceptance and use in that country ever since, particularly during the past two years. In this method, the user can specify his own alloys. Zinc can be mixed with tin and silica in any proportion desired; coatings can be made from other combinations of powdered metals.

Plastics

Particularly significant is the fact that plastics, synthetic resins, hard rubber, etc, can be sprayed with the Schori gun, opening new and untouched fields for protective coatings. Plastic coatings present a glossy appearance, perhaps indicative of the more complete fusion of particles than is usual with flake-like metallic coatings.

Schori uses a syphon effect (similar to induced draft). Powder is sucked into the air passage, and enters the flame with a stream of compressed air. Heat is controlled at the pistol handle by oxygen and acetylene valves, similar to those on the usual welding or cutting torch. A very low pressure of acetylene or propane is used, never higher than 8 lb, and more often around 2.5 to 3 lb.

Operation of the pistol is very simple. After the gun is lit and the flame adjusted, the operator slides his thumb a half inch or so to cover a small hole, and powder is sucked into the pistol. While the thumb is off the hole, the pistol sucks in air only.

I have had broad experience with this pistol, and have been permitted by the Schori Process Corp to participate in many demonstrations and experiments. We have mixed silica and zinc in progressive proportions from 95% zinc, 5% silica, to 55% zinc, 45% silica, where the two powders separated. We have also mixed other combinations of minerals and metals too numerous to mention here.

While combining different metals, the idea was born of spraying plastics and certain synthetic resins in an effort to find some substance impervious to acids and alkalis, with which we could coat tanks and vessels for corrosive liquids.

It has been a long and wearisome job to find just the right material or combination of materials that would resist and stop further corrosion on mechanical equipment already corroded. We obtained limited success by spraying hard rubber. Combinations that would resist acids would not stand up under heat over 100-110 F, but we have now found a combination that will withstand up to 400 F, both wet and dry heat, without becoming plastic and peeling off. The time does not seem far away when it will be possible to

spray dry powder to form an impervious coating that will stand up under any and all conditions on a tank or any vessel.

Possibilities of the powder-spraying pistol seem unlimited, and so far, we have only scratched the surface. Economic advantages are a factor to be considered—smaller quantities of oxygen and acetylene, propane or hydrogen are used and the sprayer can get more square footage per lb than with any other pistol so far invented. In the powder pistol, absence of moving parts makes maintenance cost negligible (with exception of the flame nozzle which may have to be renewed because of burning).

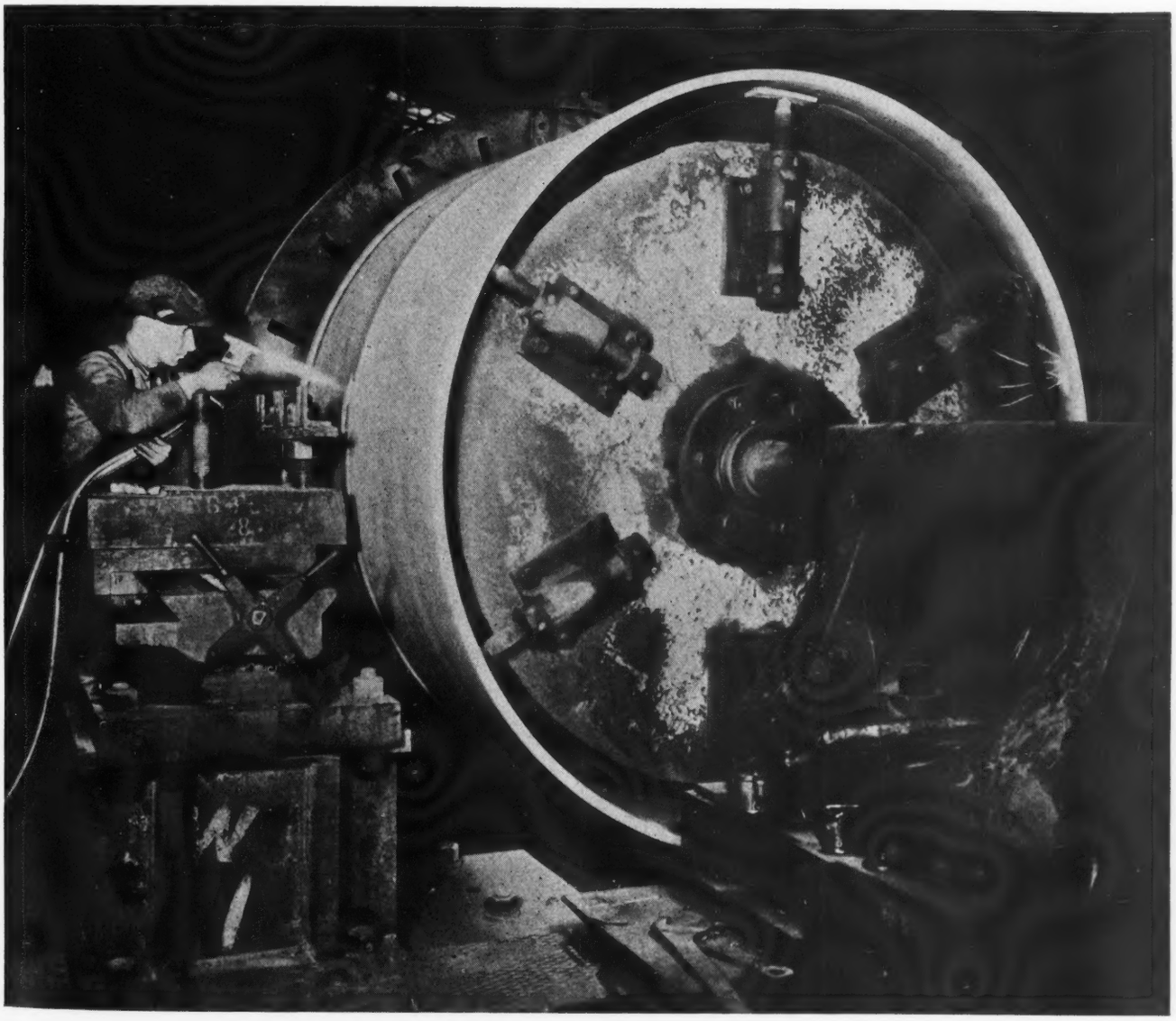
I quote from a paper by C A Rollaston, M Sc, Dept of Metallurgy, the University, Birmingham, England, prepared in 1936 and delivered before the Institute of Metals in London, March, 1937. "Owing to its low costs, the powder process will, undoubtedly, prove successful in spraying large surfaces with zinc, especially when the coat has subsequently been painted. This powder spraying pistol also offers possibilities of spraying brittle metals and alloys of high melting points which could not be drawn into wire, although deposits of the higher-melting-point metals which have been examined are not wholly satisfactory as yet."

Test Results

In a recent experiment, two plates, 12 x 12 in., one copper and one brass, were coated on one side with sprayed hard rubber and on the other with zinc to a thickness of approximately 0.031 in. The plates were then subjected to corrosive vapors, condensate, salt-water vapors, and steam at about 7-lb pressure, and then subjected to 26- or 27-in. vacuum every three or four hours. On weekends, apparatus was stopped and plates were dried out.

For nine weeks the plates were subjected to this treatment and were not examined. Also, twice during the test, the apparatus was boiled out with a solution of caustic soda, then hydrochloric acid and water for 10 to 12 hours. Vapors from the boiling solution were passed over the plates. When the plates were taken out for inspection, the rubber coating was in as good condition as when the test started, while the zinc had discolored and was peeling off. We could not find a single spot on the rubber coating that showed any sign of deterioration. On the strength of this test, three totally enclosed tanks were coated with hard rubber. After coating, surfaces were tested for bare spots with a wet sponge and a milliammeter. Only six spots were found to have a thin coating, each showing about 0.3 milliamp.

Test results indicate many possibilities for the powder pistol, particularly in the power-plant field, where corrosion prevention means dollars in pocket.



Applying bronze to a large expansion joint

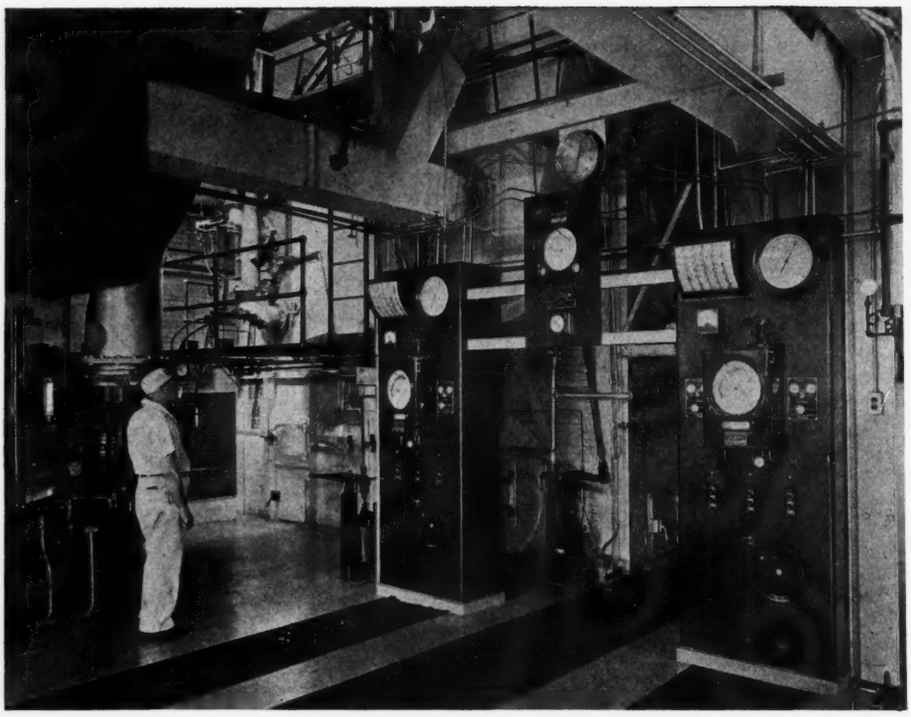


Fig. 1—Boiler plant comprises two integral-furnace boilers each fired with a unit coal pulverizer

Savings at Sucrest

Automatic combustion control reduced coal consumption enough to more than pay for the equipment in one year

By FRANK C STAPLES
Plant Manager, The Sucrest Corp

ECONOMICAL OPERATION is of paramount importance in the production of all items in industry, and steam is no exception. Many feel that, after purchasing an efficient boiler and fuel-burning equipment, little more can be done in that direction. However, we added automatic combustion control to our boiler plant, after it was seemingly complete, and have made plant operation easier and reduced operating costs below expectations.

The power plant, part of the Sucrest Corp sugar refinery of the American Molasses Co, located in the Erie Basin section of Brooklyn, N. Y., has been in operation since March 1936. For 9 months after installation, boilers were operated manually to conform with meter readings. After several months of hand operation, it became evident that complete automatic combustion control would be advisable and the Bailey Meter Co was given the contract. This equipment was installed during December, 1936, and since that time the boilers have been automatically operated.

We have kept a very close check on boiler operation to see whether this addition to our plant was actually profitable. In the table, comparison is made of operation periods without automatic control in 1936 and for 1937 with control equipment in service. These records show that for 1937, we obtained a return of 122% on our investment in control equipment, in addition to making the plant more convenient to operate.

The control system itself is shown in Fig. 2. It consists of a master steam-pressure controller and a steam-flow-air-flow controller containing free-floating air pilot valves from which air-loading pressures are transmitted through selector valves and an averaging relay to air-operated control drives. These drives are connected to the primary-air and uptake-draft dampers, while the secondary-air damper is controlled by a drive actuated directly from the furnace draft. Selector valves permit the control to be changed from automatic to manual operation during periods of starting up or shutting down a boiler.

Control

Primary control is effected by simultaneous regulation of fuel and air by the master steam-pressure controller. This controller is connected to the main steam header and establishes an air-loading pressure corresponding to steam demand, accomplished by the air pilot valve connected to a pressure coil in the controller.

Following this primary adjustment, it may be necessary to readjust air slightly to maintain correct fuel-air ratio for efficient combustion. This is done by a pilot valve in the boiler meter, actuated when motions of the steam-flow and air-flow pens are not

COMPARISON OF COAL BURNED WITH AND WITHOUT AUTOMATIC COMBUSTION CONTROL

From	*To*	*Total steam generated, lb*	*Coal used tons*	*Evaporation, lb of steam per lb of coal*
March, 1936	December, 1936	200,487,500	10,117	9.908
January, 1937	December, 1937	296,330,173	13,978	10.6

Coal that would have been required in 1937 based on 1936 operation equals $296,330,173 \div (9.908 \times 2,000) = 14,954$ tons.

Coal saved equals $14,954 - 13,978 = 976$ tons.

Saving in coal cost at \$5.09 per ton equals $976 \times 5.09 = \$4,976.84$.

Cost of combustion-control equipment = \$4,056.00.

Saving in coal cost in 1937 equals $4,976.84 \div 4,056 = 122\%$ of combustion-control cost.

equal. As long as fuel and air are maintained in proper proportions for each particular load, steam and air pens coincide and the pilot valve remains in neutral position.

However, in case the air-flow should rise above the steam-flow pen, change in the pilot-valve position causes a change in loading pressure being sent to the averaging relay. This relay is so arranged that the loading pressure sent from it to the uptake-damper-control drive is the algebraic sum of the loading pressures received from the master steam-pressure controller and the boiler meter. Therefore, any change in loading pressure sent out by the steam-flow-air-flow pilot valve will bring about a readjustment in the position of the uptake-draft-control drive until steam-flow and air-flow pens coincide, indicating best boiler-operating conditions. In order that the master pressure controller may have a preference over the steam-flow-air-flow readjustment, loading pressure entering the average relay from the steam-flow-air-flow pilot valve is throttled through a bleed valve so that the effect on the relay takes place more slowly than that from the steam-pressure pilot valve.

The power plant itself, as well as our entire new refinery, is a good example of efficient application of modern equipment. The steam-generating system comprises two Babcock & Wilcox pulverized-coal-burning, integral-furnace boilers. These boilers are capable of delivering 40,000 lb of steam per hr at 250-lb g pressure and 150-F superheat. This figure is 5000 lb per hr in excess of the guarantee. Each boiler has 4377 sq ft of heating surface consisting primarily of bent tubes between upper and lower drums. In the first pass are 3.25-in. tubes which make a slag screen preventing fouling of the boiler and superheater tubes.

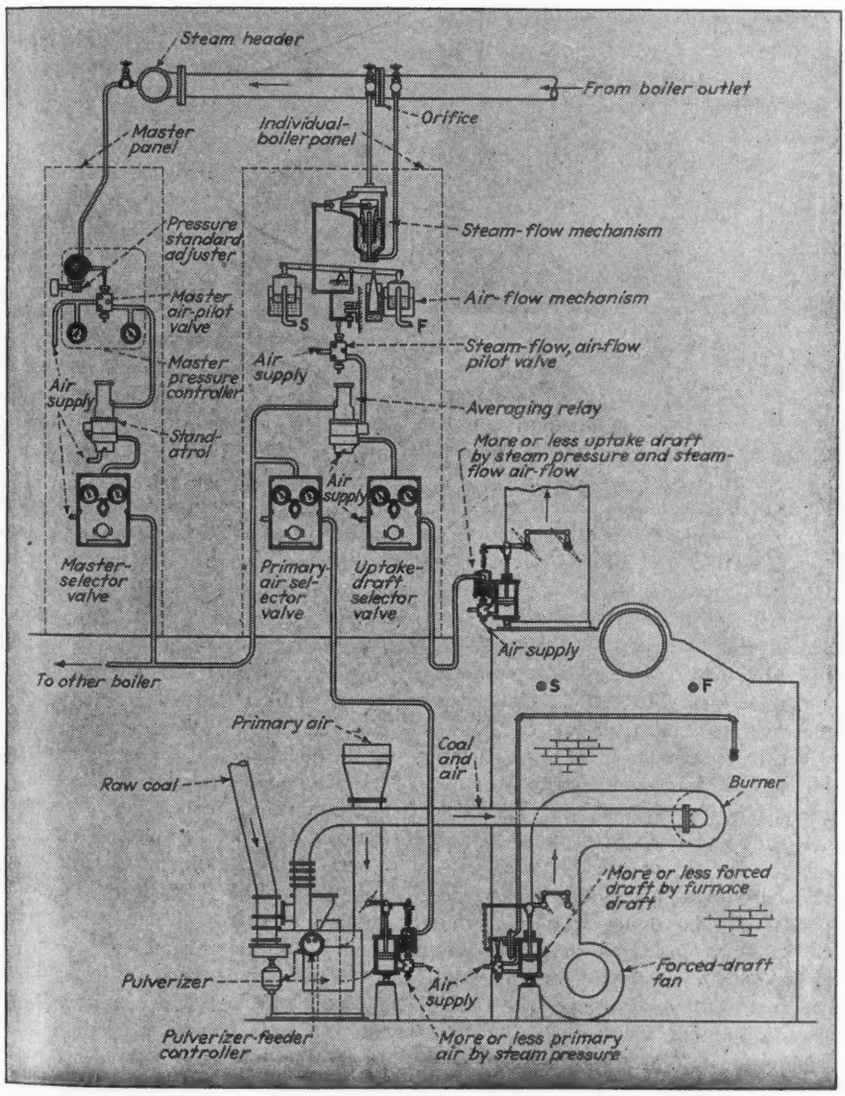


Fig. 2—Automatic combustion control applied to pulverized-coal-fired boiler

Furnace

Leaving the furnace, gases first pass through the slag screen, then with a cross flow make three passes of the remaining boiler tubes which are 2 in. in diameter. Straight tubes covered with smooth bare-metal blocks comprise the furnace floor; the two side walls are of the Bailey stud-tube type; and the rear furnace wall is of refractory construction, protected by bare, water-cooled tubes. A combined radiant- and convection-type superheater is in the first pass behind the slag screen and several rows of boiler tubes. Pratt-Daniel air heaters, each of 3650 sq ft heating surface, are directly above the boilers after the last pass.

Coal, which is transferred from storage to the 100-ton coal silo on the roof of the boiler plant, passes through automatic self-feed coal scales to the unit pulverizer on each boiler. Each boiler has two circular-type forced-draft burners, one being operated from 6000 to 22,000 lb of steam per hour, at which point the second burner is cut in.

This plant has now been operating satisfactorily for over three years. With help of the automatic combustion-control system we are realizing better efficiencies than expected when the plant was designed.

I DO *not think much of a man who is not wiser today than he was yesterday.*—Abraham Lincoln.

How to Insulate Armatures

Practical suggestions on the causes of faulty armature insulation and how to avoid them

By A C ROE
Westinghouse Electric & Manufacturing Co

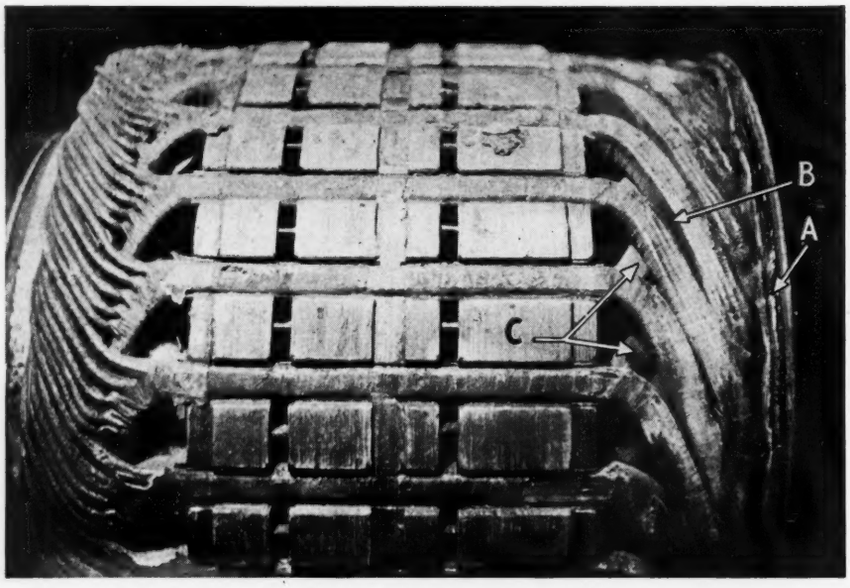


Fig. 1—A good example of how not to insulate an armature

MOST ENGINEERS do not have to rewind armatures, but are frequently responsible for the rewinding and the difficulties that develop if the job is not done properly. In this article, I have tried to give a lot of practical suggestions on intelligent use of insulation on armatures and other mechanical details of windings that insure long and satisfactory service.

Fig. 1 shows a winding that failed in a short time because of faulty workmanship. The coils were so low in the slots that the bands could not prevent them from moving, chafing off insulation and causing grounds. Insulation between rear coil ends and their support at *A* was too thick and prevented the end winding from settling to its proper position under pressure of the bands. Spaces between adjacent coil ends at *B* were not filled with insulation, which permitted coils to change their form under pressure. When the wire in the coils moved, insulation on the conductors was injured, causing short circuits between turns. Insulation strips or pads were not provided between top and bottom layers of coil ends at *C*. This winding was quite loose, as striking it any place with a mall produced a dull hollow sound and caused coils to move.

Winding an armature is comparable to building a house. A firm and properly constructed foundation is essential to the success of both. With the armature winding, coil supports and their insulation may be classed as the winding foundation.

On most armatures, metal supports are at both front and rear ends of the core. They provide a base on which coil ends and leads are supported and secured in place with banding wire. How successful a winding will be depends in a large degree on how the coil ends are insulated and supported.

Too much insulation on the coil supports will require excessive band pressure which may crush the end windings. A 3/16- to ⅛-in. thickness of insulation is ample for voltage up to and including 600 volts. Do not use any more insulation than this unless necessary to build up the coil support to a proper height.

Many old-type armatures have their rear end winding inclosed in a metal section, as in Figs. 1 and 2. Ventilation of the windings and their supports can be improved by putting the stripped armature in a lathe and turning off the vertical part of the support, as in Fig. 3. The support is then insulated in the usual manner, which is easily done. When possible, have the insulation extend about ¼ or ⅜ in. beyond the end of the winding to increase the distance from the metal over the insulation to the coils. This change gives an open-end winding supported at the bottom that will operate at about 10-F lower temperature.

End Windings

In Fig. 1, the end windings have not been properly protected between the layers of top and bottom coil ends, at both ends of the armature. These parts of any armature are the most vulnerable and require careful attention to their insulation for trouble-free operation. Space between the top and bottom coil end is usually zero where the coil comes out of the core and increases to a maximum at the coil end. Method of treating this space depends on type of coil and length of coil extension, but the space should be filled with insulation so that band pressure will not crush or deflect the upper coil ends. The insulation pad should support the upper layer so that band pressure locks the two layers of coil end to the coil supports. This requires that the insulating pad between the end of coils be made up of several layers of material, stepped to give desired thickness.

Example of stepped insulation pads between top and bottom coil ends are shown in Figs. 4 to 6. A 7-layer insulation pad *A* is used in Fig. 4 between the rear coil ends of a wire-wound drop-type winding. Note the additional small pad at the ends of the coils and how it is placed between the two wide layers of insulation between the top and bottom layers of coil ends. In Fig. 5, a 5-layer insulating pad *B* is used between the

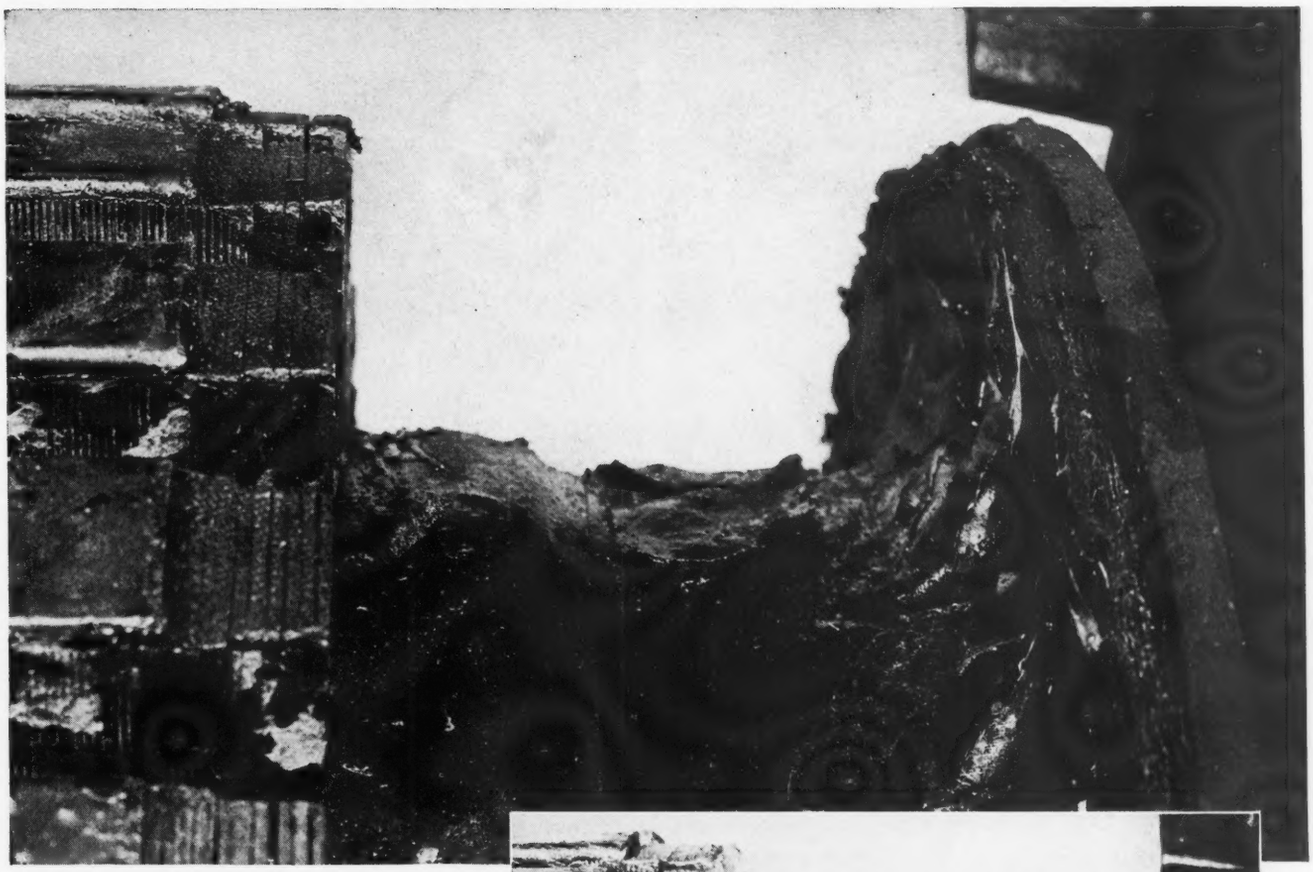


Fig. 2—This is not the crater of an extinct volcano, but the rear armature-coil-end support before the old insulation was removed

layers of front coil ends of the same winding shown in Fig. 4. One layer of insulation in both figures extends up, at each end of the winding, to the slot insulation. This treatment not only supports the coil ends but insulates one layer from the other.

Fig. 6 shows how effectively the insulating pad at *A* supports the upper layer of coil ends. This illustration is Fig. 4 with the pad trimmed off close to the coil. These filler pads are a must item on all wire-wound coils and the smaller the wire in the coils, the more important it is that these pads be used, to prevent the coil end from collapsing and causing short-circuits.

On many armatures wound with drop-type coils, small pads (approximately 2x3 in.) are required between the ends of each coil as it is placed on the armature, as at *B*, Fig. 6. These pads extend either side of the end of the coil and over the layer of bottom coil ends. Between the layer of coil ends, the multiple-layer pad extends from the core to the edge of the pads between coil ends. Extending under the bottom of the coil ends, the small pads give extra insulation between the layers where the band pressure is the greatest.

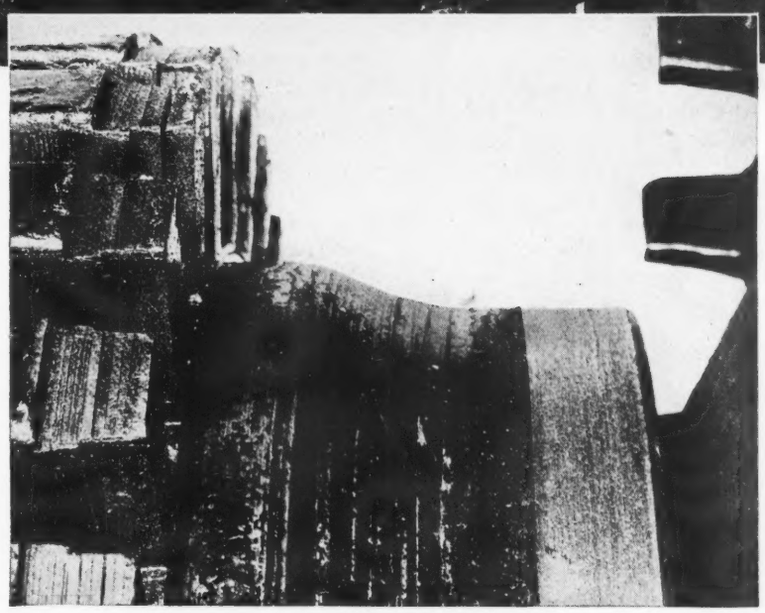


Fig. 3—Coil-end support, Fig. 2, after its vertical section had been machined off

At the rear end of the coils, the small pads are applied to protect the lower half of the diamond point and extend between the bottom adjacent coil ends, but not under the bottom of the coils.

On many armature windings it is necessary to provide protection between the bottom layer of coil leads and the coil ends as at *A*, Fig. 5.

This protection varies in method of application, but the object is the same in all cases. Obtain maximum protection but keep insulation thickness at a minimum. These pads must be flexible and strong, and have good insulating qualities. In Figs. 4, 5 and 6, note the neat thin layers of insulation over and through the coil ends without causing bulk.

To insure a tight end winding and to prevent collapse of the coil ends and to obtain an arch-bound winding, filler pieces *A* are necessary between adjacent coil ends in the area to be covered by the bands, Fig. 7. These fillers should be a driving fit and should arch-bind the winding when it is pulled down onto the coil-end support. These filler pieces should

Fig. 4—A 7-layer stepped insulation pad between top and bottom layers of rear coil ends to insulate and support coils

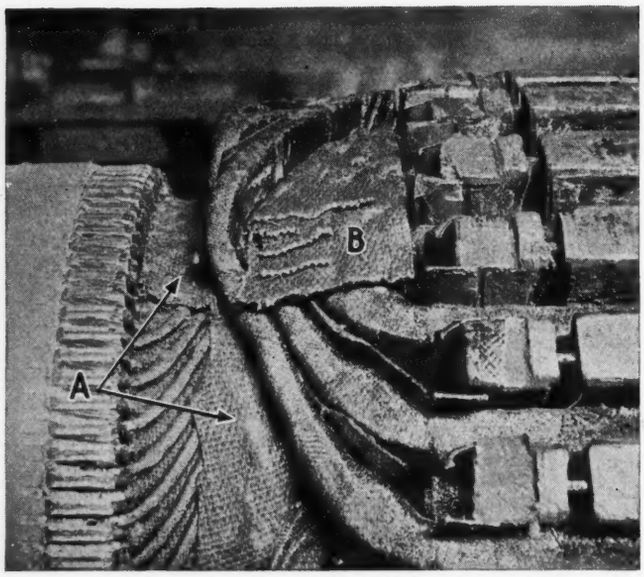


Fig. 5—A 5-layer stepped insulation pad between front layer of coil ends of the armature, Fig. 4

be wide enough to cover the depth of the coil ends. In Fig. 7, note how square and true the coil ends are and how the fillers support the coils.

These fillers can be used to separate parts of the winding, that if allowed to touch, might eventually break down and cause a short circuit. An example of this is where the filler strips extend out past the diamond point of the coil ends. This prevents chafing of the coil ends and eliminates the need for a separate insulating pad between them, as in Fig. 6. End room available determines which method is best suited to a given job.

In any armature winding, there is always a proper balance between insulation and copper that should be maintained. Too much insulation, like too little, is likely to cause trouble. Too much insulation on coil supports will change the angle of the coil ends and will raise the whole winding and make necessary excessive pounding and banding pressure on the windings to bring them within proper dimensions.

An example of too much insulation that caused winding failure is that of several rewound armatures developing short circuits in the end windings. A checkup showed that the top half of the coil ends were crushed into the lower half to get the armature winding to size, because the old core insulation had been covered with new. Removing all the old insulation and using the correct amount of new eliminated the trouble. In another case, too much insulation on the coil-end supports left the winding too high. Too much pressure by the bands on the ribbon-wound coils distorted the end loops into sharp kinks that cut the insulation.

Troubles of this kind are legion, but the cure in all cases has been to remove excessive insulation in some places and to restore it to propre thickness in other sections to get a proper balance of insulation on the winding. It is important, when stripping an armature for rewinding, that a careful record be made not only of the winding, but also of the distribution and thickness of insulation. Unless this is done it may be difficult to restore the winding to its original condition.

Fig. 6—Pad between rear end of coils trimmed back to show how pad gives support to coil ends under band

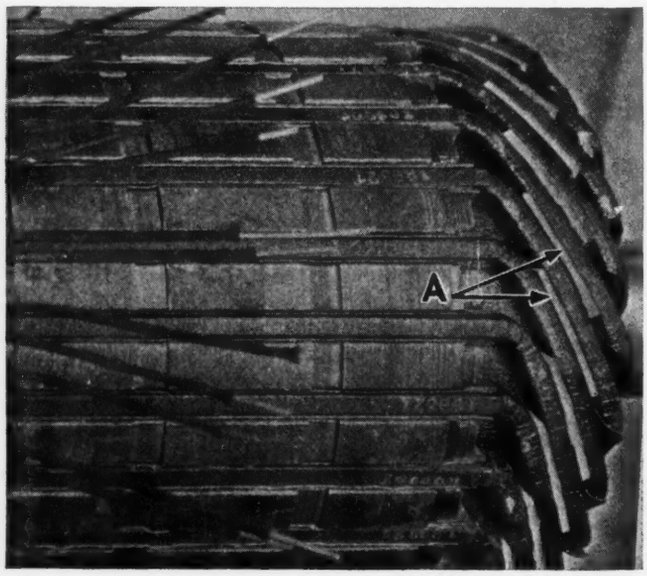
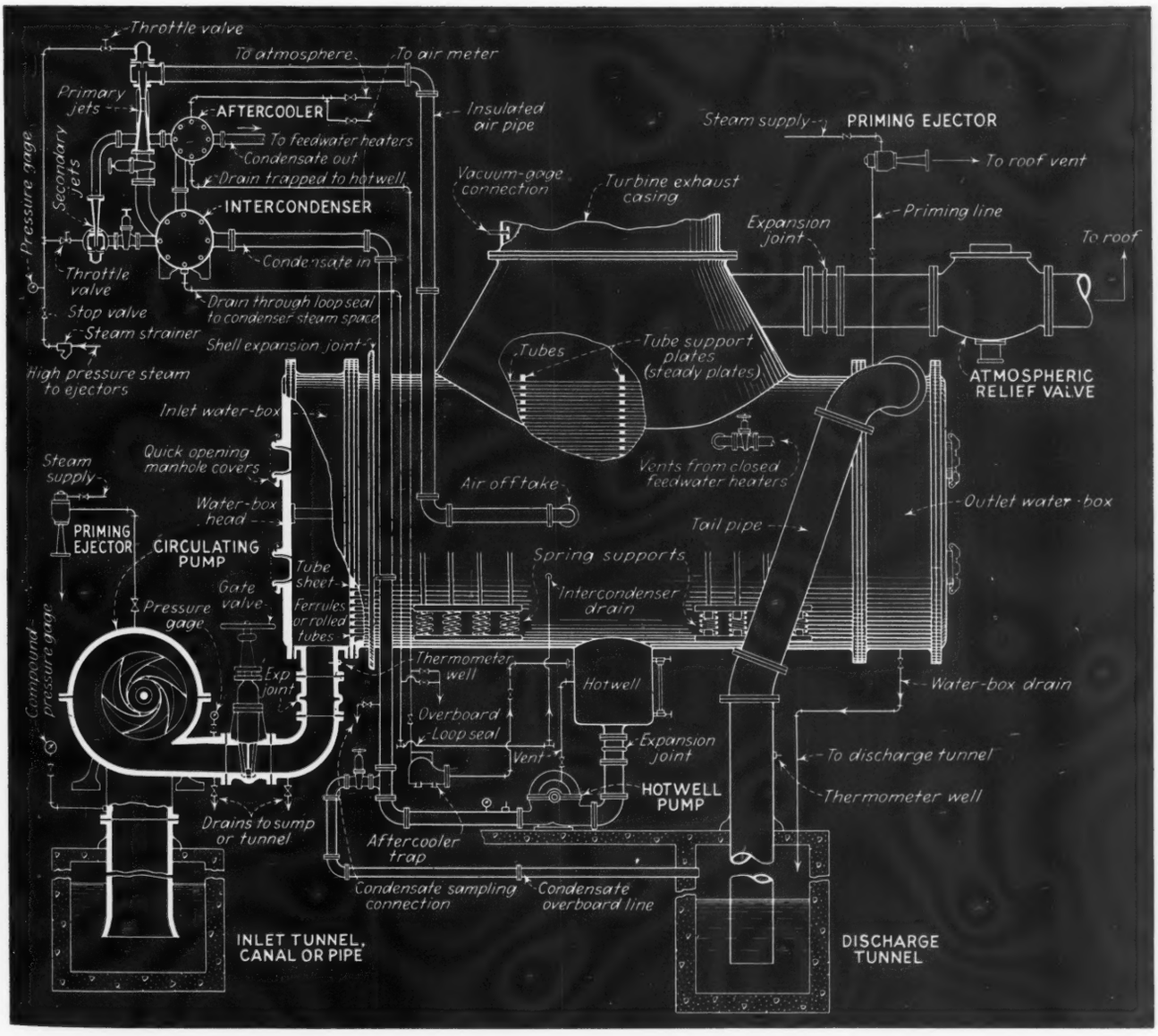


Fig. 7—Filler pieces placed between the coils gives added support to prevent them from being distorted by band pressure

STEAM CONDENSERS

A steam-condenser installation represents far more than a bundle of tubes strategically arranged in an airtight shell. To keep vacuum at the prime-mover exhaust takes at least three kinds of pumps, large and small piping, an assortment of valves. To keep best possible vacuum takes also some thermometers, pressure and vacuum gages, records, and above all an effective cleaning program. Twelve pages here summarize modern surface-condenser practice from fundamental design to everyday operation.



HOW CONDENSERS GET THAT WAY

» THE FIRST practical heat-operated prime mover was not a steam engine, it was a condenser. Steam entered the cylinder of Newcomen's pumping engine at atmospheric pressure and the actual work was done by the condensing action of water sprayed directly into the cylinder. Watt separated the water-spray chamber from the cylinder and the first direct-contact condenser was born.

Strictly speaking, a condenser is any device for converting vapor to liquid by taking away heat. While condensers are also used for ammonia and other refrigerants, largest application is the production of vacuum at the exhaust of power-producing turbines. Space limitations prevent covering in these pages the many special types of condensers for vapors other than steam.

Steam condensers are not usually thought of as power producers, but a pound of steam does about as much work expanding from atmospheric pressure to 29-in. vacuum as it does from 200 lb. 600 F to atmosphere. A secondary function is to produce feedwater of high quality demanded by modern high-pressure boilers.

Developments

Condensers are either direct contact or surface (in which steam and water exchange heat through a metal tube). Direct-contact condensers are high-level (barometric) or low-level with a pump for air and water removal. Direct contact condensers cost less but, in general, have a higher operating cost than surface types. Also, feedwater needs of modern boilers have eliminated consideration of direct-contact condensers in present-day high-pressure power plants.

Developments in condenser practice during the last 15 years are: (1) practically complete change from cast-iron shells to welded-steel construction, (2) improved arrangement of tubes and baffles to produce 50% higher heat-transfer rates, (3) a wide assortment of alloy tube materials, (4) general acceptance of rolled-in tubes, (5) widespread use of chlorine and chlorine compounds to replace other methods of tube cleaning, (6) axial-flow or propeller-type circulating pumps, (7) almost universal use of steam-jet air ejectors to replace reciprocating and hydraulic-vacuum pumps.

Welded Shells

Steel-plate shells fabricated by welding are not only lighter than cast iron but are permanently airtight and can be better adapted to unusual turbine-foundation problems without restricting steam flow. Reinforcing ribs, I-beam construction, internal bracing, water-impingement gratings and expansion joints are features of several designs, development of which has been encouraged by adaptability of welded construction.

A new development is the provision for reversing water flow in a 2-pass condenser to clear inlet tube sheet of leaves or trash. A nozzle (or plate) at the inlet water box changes direction of flow when operated by a worm wheel.

Cast-iron water boxes required for sea water can, of course, be attached to a welded-steel shell; for fresh-water service, welded-steel water boxes can be supplied.

Welded construction has also permitted taking better advantage of the natural expanding effect of steam in the connection to turbine exhaust. By tapering the connection more gradually into the shell which, in turn, is provided with a dome or expanded portion, distribution of steam toward the end sections of the condenser is improved.

Weight of a condenser, water boxes, tubes and water is usually supported on springs, the shell being rigidly attached to the turbine-exhaust casing. When solid supports are used, an expansion joint is required between condenser and turbine to protect the turbine from expansion strains. A system of weighted levers has also been employed to keep load carried by the supports constant under all temperature conditions.

One disadvantage of an expansion joint is that when it is inserted between turbine and condenser, vacuum produces a vertical force (amounting to about 14 lb per sq in. of exhaust-connection area) that tends to lift the condenser and pull down the turbine.

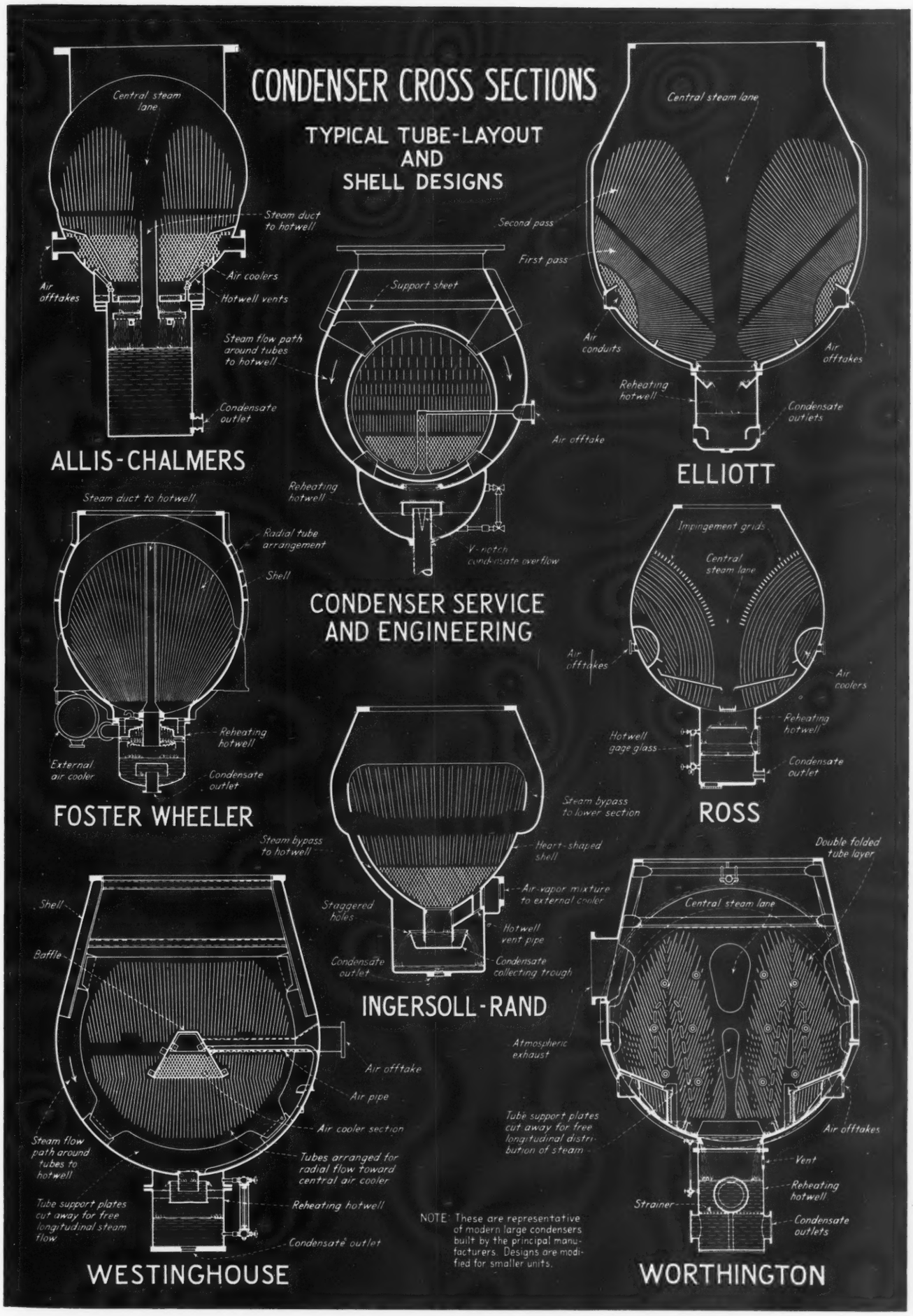
Differential expansion between brass tubes and steel shell can be taken care of by a complete ring expansion joint when the tubes are rolled in at both ends or by bowing tubes upward at the center, intermediate support plates being raised an inch or more to bow tubes upward. Both methods have proved satisfactory.

Steam Flow

Steam leaves the last wheels of the turbine at high velocity and in very large volume. At 29-in. vacuum, steam occupies about 40 times as much space as a corresponding weight of air and 36,000 times as much as liquid water. Steam lanes between tube rows must be widely spaced to allow these large volumes to enter the tube bank, and can be very closely spaced at the end of the flow path near the air-cooler section or air offtake where volumes are small.

Arrangement of tubes has been the subject of much discussion, calculation, and experimental investigation. Testing of models, measurements of isolated-tube performance and over-all tests of final design have provided information that has been important in raising performance of modern designs over those of, say, 15 years ago. Net result of better performance is that a smaller condenser of modern design will do the same work that would have required 20 to 40% more surface in 1925. As a result, tube-sheet layout has become an identifying trademark of each manufacturer's contribution to better performance.

High velocity of steam entering a condenser is utilized in some designs by a wide and more or less venturi-shaped lane down the center of the condenser leading to the hotwell. Velocity energy is, to a certain extent, converted into pressure head and the static pressure in the neighborhood of the hotwell can actually be greater than at the turbine exhaust. This ef-


CONDENSER CROSS SECTIONS
TYPICAL TUBE-LAYOUT AND SHELL DESIGNS
Central steam lane
Steam duct to hotwell
Air offtakes
Air coolers
Hotwell vents
Steam flow path around tubes to hotwell
Condensate outlet
ALLIS-CHALMERS
Second pass
First pass
Support sheet
Air offtake
Reheating hotwell
V-notch condensate overflow
Central steam lane
Air conduits
Air offtakes
Reheating hotwell
Condensate outlets
ELLIOTT
CONDENSER SERVICE AND ENGINEERING
Steam duct to hotwell
Radial tube arrangement
Shell
Reheating hotwell
External air cooler
Condensate outlet
FOSTER WHEELER
Impingement grids
Central steam lane
Air offtakes
Air coolers
Reheating hotwell
Hotwell gage glass
Condensate outlet
ROSS
Steam bypass to lower section
Heart-shaped shell
Steam bypass to hotwell
Air-vapor mixture to external cooler
Staggered holes
Hotwell vent pipe
Condensate outlet
Condensate collecting trough
INGERSOLL-RAND
Double folded tube layer
Central steam lane
Atmospheric exhaust
Tube support plates cut away for free longitudinal distribution of steam
Air offtakes
Vent
Reheating hotwell
Strainer
Condensate outlets
WORTHINGTON
Shell
Baffle
Air offtake
Air pipe
Air cooler section
Steam flow path around tubes to hotwell
Tubes arranged for radial flow toward central air cooler
Tube support plates cut away for free longitudinal steam flow
Reheating hotwell
Condensate outlet
WESTINGHOUSE
NOTE: These are representative of modern large condensers built by the principal manufacturers. Designs are modified for smaller units.

fect is used to counteract the tendency to undercool the condensate and under some conditions gives higher-temperature condensate than that of steam at turbine exhaust.

It is not only necessary to provide a proper steam-flow path by arrangement of tubes, but it is also important that steam get to the ends of the condenser and pass over all parts of all tubes at sufficient velocity to prevent air accumulation. This is accomplished in a variety of ways: (1) by compartmenting the condenser with tightly fitting support plates and using separate ejectors on each compartment, (2) by cutting tube-support plates away between tube banks to allow as free longitudinal flow as possible, and (3) by compartmenting the air-offtake arrangement.

In a single-pass condenser, much more steam must get to the cold end of the tubes because of the cooler water and corresponding greater temperature difference.

It should be pointed out that all design items of this nature contribute to the over-all heat-transfer (vacuum) performance. The engineer and operator need concern themselves only with the manufacturer's guarantee of performance and a test of sufficient accuracy to assure that the guarantee has been met.

Water Flow

Amount of circulating water available, its temperature and distance it has to be pumped determine number of water passes. Obviously, at sea level with unlimited water at low total head, large condensers with long tubes should be single pass. Under the same conditions, small condensers with shorter tubes show less advantage in over-all economy for single-pass design, but the trend is still in that direction. Where water is scarce, expensive or pumped at high head, 2-pass designs are used; only in very small sizes are more than two passes employed.

Vertical condensers avoid silt deposits in tubes and can be set in concrete pits where river level varies many feet. Horizontal units have now been applied satisfactorily to similar conditions. Vertical condensers require external hotwells and have not had wide application. In some cases, two condensers are provided one on each side of the turbine. Recent condensers of this type connect to piping beneath the floor eliminating all large piping in the turbine room. Pumps for this installation are in a separate house on the dock.

Divided water circuit can be provided whether the condenser is single or double-pass. Advantage, of course, is that failure of one pump does not immediately shut down the entire unit and that one-half the waterbox can be entered with somewhat reduced load on the turbine. Separate air off-takes from each half of the condenser are required if the division is vertical to avoid blanketing air jets with hot steam; with the horizontal water-box division of one manufacturer, this is not necessary.

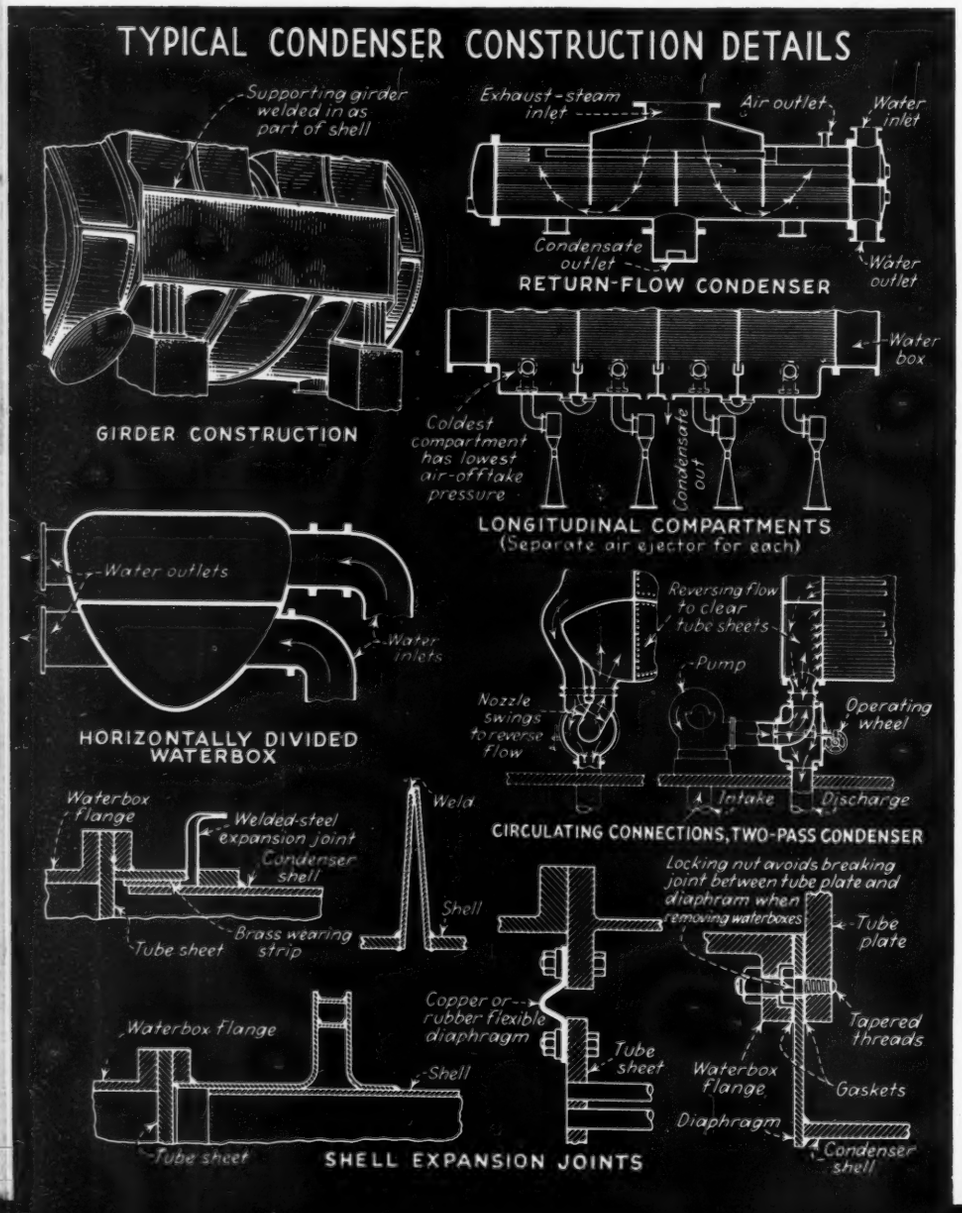
A few large condensers have been installed without any cooling-water-piping valves. This saved the cost of three large valves and has not offered any serious handicap to operation.

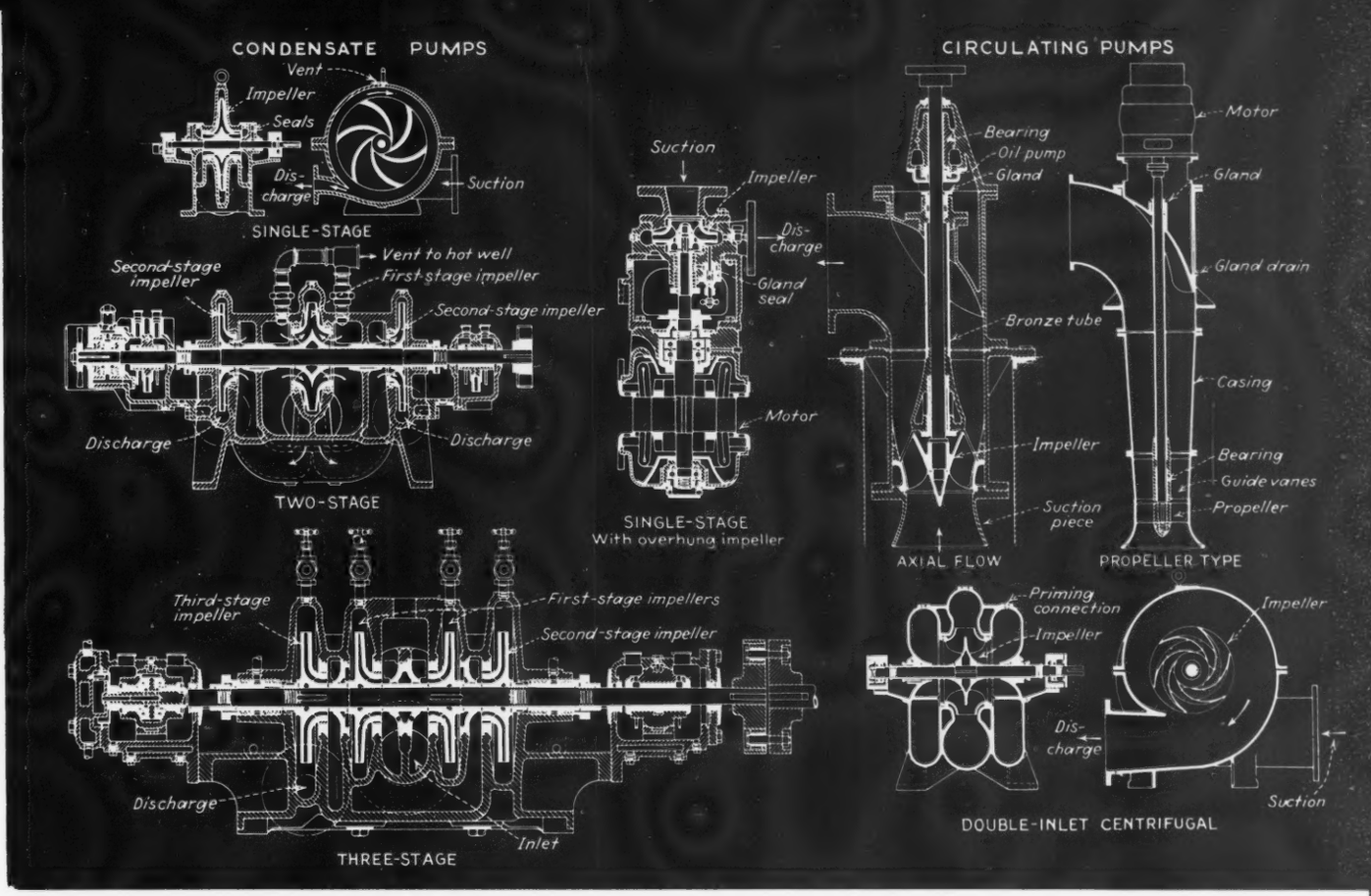
Water velocity in piping should not exceed about 8 fps and connection to the inlet waterbox should be designed to introduce as little turbulence as possible. Model testing and experience in the field have resulted in more generous size of waterbox and connection, and have produced several designs aimed at smoothing out water flow. No experience can be quoted, but improved water-flow conditions have cost little and probably have reduced tube-inlet erosion. Pipe material is usually cast iron.

A recent development is equipping the water-box covers with glass plates and illuminating the inside of the waterbox. A leaky tube can then be detected by putting a slight air pressure on the steam space and watching tube ends for bubbles. This eliminates need for filling the steam space with water, thus speeding up locating of leaks. Another development is a compound injected into the circulating water which will plug small leaks.

Pumps

In centrifugal volute pumps for circulating-water service, a large double-inlet impeller turns at low speed and water leaves the runner approximately at right angles to the shaft. Propeller pumps, as the name implies, have a shallow runner turning at relatively high speed and water flow is essentially parallel to the shaft. Propeller pumps include several gradations from nearly axial flow for low head, high speed, to those partway between centrifugal





Condensate pumps operate under high suction and high head; circulating pumps move large quantities of water at relatively low heads

and propeller types, water leaving the impeller at an acute angle to the shaft. Diffusion vanes straighten out the swirl above the runner.

For simplicity, those for highest speed can be called propeller pumps, for somewhat lower speeds, axial-flow pumps. In the latter class some centrifugal effect is utilized.

Axial-flow and propeller-type pumps are favored because they require much less floor space than centrifugal pumps and the impeller can often be located below intake water level, thus eliminating need for priming.

Running at higher speed, axial-flow and propeller pumps can use a smaller and cheaper motor than centrifugal pumps for the same hp required. Propeller pumps build up a high head as flow decreases toward shutoff and provision must be made to avoid overloading the motor in starting. Axial-flow pumps have this characteristic to a much less extent. The high-head characteristic of both types can be used to advantage in "throwing" the water over the tailpipe in starting before a discharge water leg is established.

Condensate pumps have to handle water at high vacuum within a few degrees of its boiling point. Piping connection from hotwell to pump should therefore be of ample size (calculated for 4 fps velocity or less) and have a minimum of fittings. Vanes in the connection to the hotwell avoid a swirl entering the pump.

Centrifugal pumps suit this service best and can be single-, 2- or 3-stage depending on total head required to pump through heaters and piping system.

Sealing glands against air (oxygen) infiltration are essential to avoid corrosion of heaters, piping and economizers. Multistage pumps are arranged so that both glands are under discharge pressure; single-stage pumps have special sealing connections. A separate water seal for starting should be provided. Condensate-pump suctions should be vented to the hotwell to avoid steam or air binding.

Hotwell

The condenser hotwell not only stores condensate and assures maintaining a water head on the pump, but also reheats condensate that has been chilled by passing over cold tubes and does a major part of the deaeration necessary to prevent oxygen corrosion. With modern designs, oxygen is kept below 0.03 cc per liter.

Drains

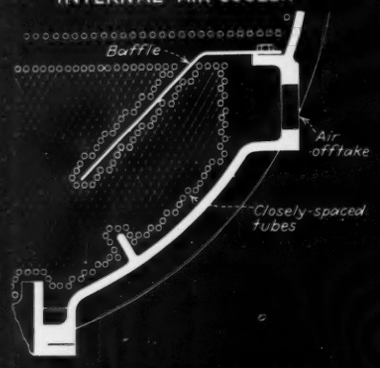
Heater vents and other drains below atmospheric pressure have to be connected to the condenser shell. This piping and the vented equipment represent possible sources of air leakage and care is required throughout design and installation to eliminate air infiltration from this source as far as possible.

Priming System

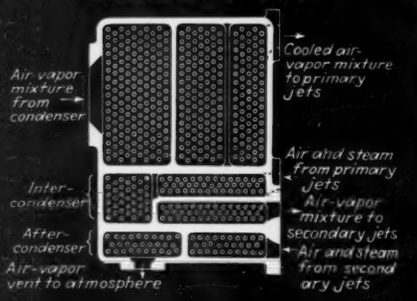
Where centrifugal circulating pumps are used, at least two priming connections are required to fill the pump with water and aid in establishing tailpipe water leg. These connections are taken from the top of the pump and usually the top of the tailpipe. Simplest arrangement from an operating standpoint is a separate steam jet at each connection exhausting to the atmospheric relief line. A single jet can be connected to both points, however, or the pump can simply be vented to the waterbox or tailpipe with a valved connection. Small installations often connect priming points to steam-jet air ejectors serving the steam space. In these cases, a butterfly valve in the air offtake pipe allows holding higher vacuum in the water space than in the shell in starting. Priming connection should run up 34 ft above high-water level in intake canal to eliminate possibility of drawing cooling water into the condensate system and thus contaminating the feed water.

AIR REMOVAL

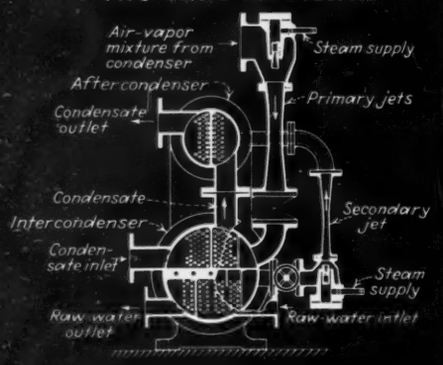
INTERNAL AIR COOLER



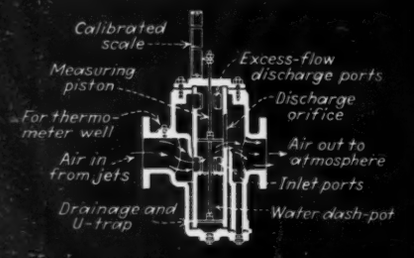
EXTERNAL AIR COOLER


Cooled air-vapor mixture to primary jets
Air-vapor mixture from condenser
Air and steam from primary jets
Inter-condenser
Air-vapor mixture to secondary jets
After-condenser
Air and steam from secondary jets
Air-vapor vent to atmosphere

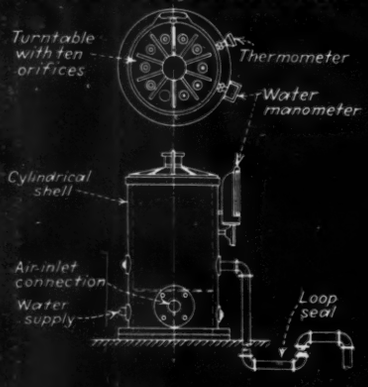
TWO-STAGE AIR EJECTOR



PISTON-TYPE AIR-LEAKAGE METER



ORIFICE-TYPE AIR-LEAKAGE METER



» A CERTAIN AMOUNT of air unavoidably enters every condenser system from turbine glands, drains, heater vents, gasket leaks and the like. Amount of leakage has little to do with the size of condenser, some small condensers having 10 to 15 cfm leakage and some of the largest as low as 2 or 3 cfm. Air removal equipment is designed to handle much more than expected leakage for starting up and contingencies.

Types of Air Pumps

In general, condensers are equipped with one or more of three types of air-removal equipment: (1) reciprocating dry-vacuum pumps, (2) so-called "hurling-water" pumps and (3) steam-jet air ejectors. In new installations and for replacement, the steam jet has replaced other types because it has no moving parts, is relatively free from maintenance and is usually more economical to operate.

A steam-jet ejector is a simple vacuum pump that employs the compressor action of a high-velocity jet of steam. A nozzle discharges a jet of steam at about 3500 ft per sec through a venturi-shaped tube, entraining air and vapor from the condenser. One, two or three stages are used depending on the vacuum desired and two or three jets in parallel can make up each stage. Two-stage ejectors are most common.

Air ejectors (also dry-vacuum and hurling-water pumps) perform best when all possible vapor is condensed and removed before the air reaches the jets. Final condensing of steam from air-rich mixture and cooling of the resulting saturated air-vapor mixture is accomplished either in an internal air cooler, usually a group of tubes baffled off from the main bank, or in an external air cooler.

Location of air-cooler section within the condenser, air off-take arrangement and preference for external coolers are important items of condenser design entirely in the hands of the manufacturer. Since these items affect over-all vacuum performance, it is beside the point to discuss the merits of one air-cooler design or another except as part of a whole condenser installation. External air coolers, however, require additional cooling-water piping, valves and strainers.

Inter- and Aftercondensers

A single-stage ejector can be vented to atmosphere for the discharge of air and steam mixture from the jet. A 2-stage ejector requires that first-stage steam be condensed and air-vapor mixture again cooled before passing to the second-stage jet. This cooling is usually accomplished in a shell-and-tube intercondenser using condensate as cooling medium to recover ejector-steam heat.

An aftercondenser recovers heat from the final-stage steam, permits measuring air leakage and avoids exhausting steam to atmosphere. For use in starting, when no condensate flow is available, the aftercondenser can (1) be arranged with a separate raw-water section or (2) a by-pass control provided to recirculate condensate back to the condenser shell. Three-stage ejectors require two intercondensers and one aftercondenser.

Condensate from the intercondenser is usually returned to the condenser shell through a loop seal. Intercondenser steam space operates at high vacuum, 22 to 26 in., requiring a 10- to 15-ft water-leg seal.

The aftercondenser operates at atmospheric pressure. Drain can be piped to an open feedwater heater or trapped to the hotwell.

Piping and Valves

Nozzle openings in steam jets are small; steam-supply lines should be provided with strainer and blow-off connection to prevent dirt in steam line reaching ejector nozzles. Steam piping and ejector should be lagged.

Air-supply line from condenser to primary jet should be ample size and as short as possible to reduce pressure drop to a very minimum. If long, or exposed to heat, the line should be lagged so that air is delivered to jets as cool as possible.

TUBES

» TUBE SIZE and length are determined by manufacturers as part of condenser design. Thickness, material and method of packing are usually specified by the purchaser for new installations and replacements.

Dimensions, quality of material and workmanship are best covered by referring to latest Tentative Revised ASTM Specifications for Seamless Condenser Tubes and Ferrule Stock (ASTM Standards, 1936, Part I).

Most condensers have No. 16 or 18 Bwg tubes. The heavier No. 16 gage is more apt to be chosen where steam-impingment vibration is a problem. It is difficult to justify tubes thicker than No. 18 on the basis of longer life against most corrosion.

Materials

Admiralty metal for sea water and Muntz for inland service were traditional materials for many years. Several newer alloys have justified their higher initial cost for certain locations, but no single recommendations can be made for all conditions.

In general, arsenical copper has practically superseded Muntz for fresh water service and several installations of aluminum brass are standing up well in salt water. Admiralty and arsenical copper cost about the same, aluminum brass 30% more. Arsenical copper can be drawn as hard and strong as Admiralty.

Copper, arsenical copper and red brass resist dezincification best. Considerably higher cost of copper-nickel tubes has limited their use to extremely corrosive conditions. Many special alloys are marketed under manufacturers' trade names and recommended for special conditions.

Corrosion

Tubes resist corrosion by forming a thin layer of scale. Any irregularity, change of flow velocity, or release of dissolved gas sets up a local electrolytic cell which can counteract the self-healing tendency of the protective scale and accelerate corrosion.

Tube corrosion shows up in three ways (1) inlet corrosion-erosion, (2) attack throughout tube length resulting in general thinning or pitting, and (3) dezincification. Use of flared brass inserts, or coating 6 to 8 in. of the tube with bitumastic paint have effectively prolonged tube life.

Inserts should be tapered at the trailing edge to avoid pits and have to be replaced periodically. Installing a perforated baffle in the water box tends to hasten liberation of entrained and dissolved air, which can then be vented to the top of the tail pipe. Such baffles interfere somewhat with tube cleaning and removal.

General thinning and pitting are rare if proper tube material is used. Pitting, however, can be serious if a thick coating flakes off in places when dried out. The same is true of scale accumulations if they become discontinuous. Tube life may even be prolonged by a thorough scraping, wire brushing or sandblasting down to new metal in such cases.

Dezincification, whether of the "plug" type or general throughout the tube, clearly calls for a change of tube material.

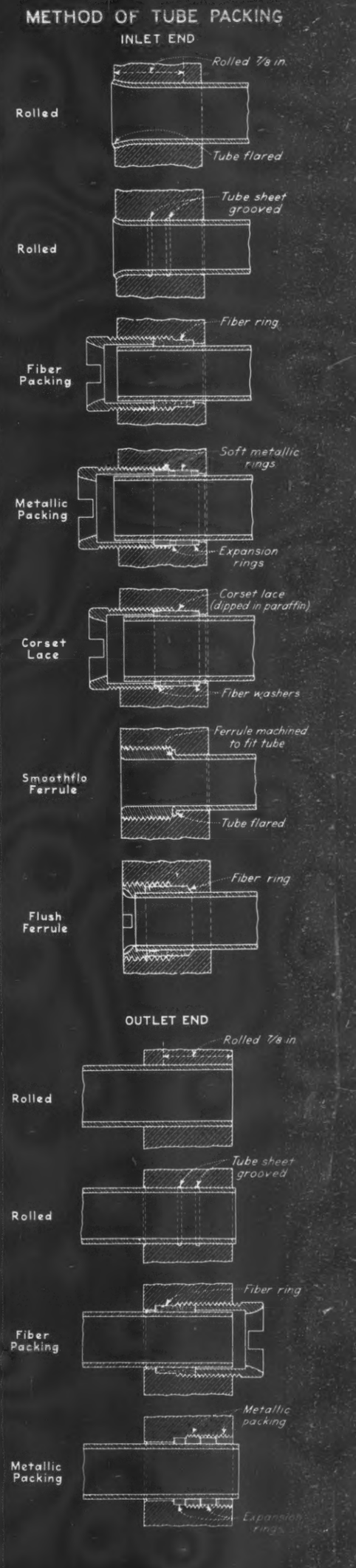
Packing

Most condenser manufacturers recommend rolling the tubes into both inlet and outlet tube sheets, taking care of expansion by a welded-steel joint in the shell or by bowing tubes. Seventeen installations reported by Edison Electric Institute (Dec, 1938) rolled tubes in at both ends and only six indicated use of any form of packing. All of the latter used metallic packing.

Disturbance to water flow at tube inlet caused by the ferrule, is eliminated by rolling. The tube sheet is first faced with a radius tool to form a bell mouth. The hole can be left plain, cut with a few relatively deep grooves, or many small ones. Grooves increase the holding power of the roll. Expanding should leave no shoulder or sharp edges.

Tubes can be rolled into existing tube sheets drilled and tapped for ferrules by first inserting a brass bushing. Another way is to roll or flare the tube against metallic packing.

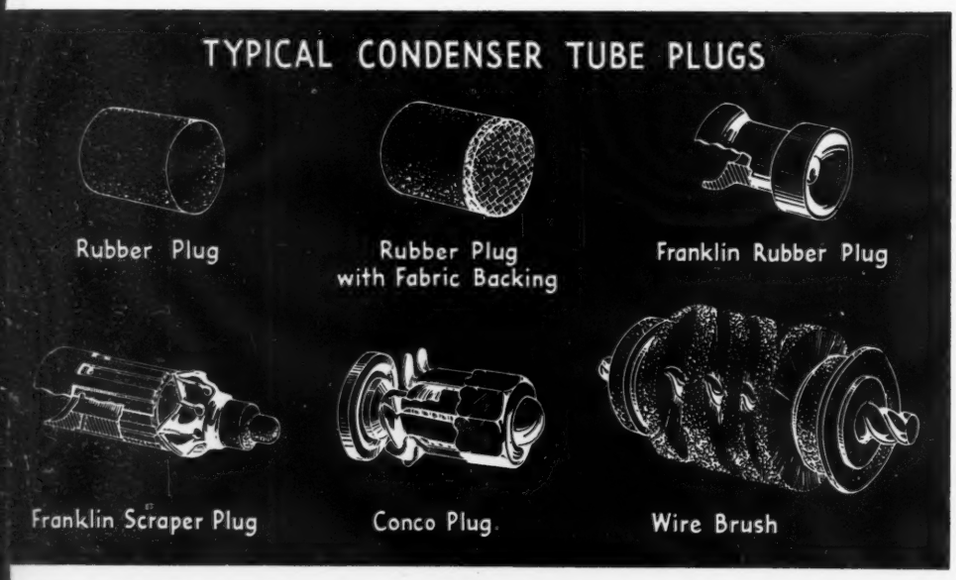
Flush ferrules have been developed for cases where packing is considered necessary at tube inlets. Slots are shallow or eliminated altogether and special tools are required for removing ferrules. Where rolled outlet ends are considered undesirable, metallic packing without a ferrule is preferred to corset lace or fiber packing.



HOW TO KEEP

» RARE IS THE CONDENSER that needs no tube cleaning. Only a few plants on inland lakes are free from some form of accumulation on the water side of the tubes, and even these may have slime formation at some seasons of the year.

Tube cleaning can be either periodic removal of built-up coatings or more or less continuous preventive treatment. If the coating is slime (algae), part or all living organisms, it is generally better to discourage growth with chemical treatment poisonous to the particular bacteria or algae that constitutes the slime.



Chlorine and its compounds have been found the most effective poisons. If the formation is inorganic, or the organisms are already dead, the accumulation must be removed mechanically or dissolved chemically.

There is little difference in the cleaning problem between fresh-water and sea-water supplies. Algae are present in the best of drinking water (before chlorination) as well as the most polluted harbor. Type and form of organism varies widely, however, and treatment must suit. Sea water rarely forms a true scale while some fresh waters do, particularly if they contain silica or are alkaline and contain dissolved calcium and magnesium salts.

Most deposits on tubes are caused by cellular, gelatinous organisms, colonies of which hold dirt together to form slime. After a period, slime can become compacted into a tough, leatherlike skin that can, in extreme cases, cut the heat transfer of a tube in half.

Plugs

Traditional method of tube cleaning is to shoot rubber plugs through the tubes with 80 to 100-lb air pressure once a week. Rubber plugs are cheap, can be used many times and remove much of the loose slime. They do not remove any scale, tend to compact the slime into a dense coating, and require limiting turbine load or complete outage of the machine at regular intervals. Where slime growth is heavy and rapid, tube cleanliness averages from 50 to 70%.

Various plugs have been developed in an effort to increase cleaning action without causing damage to the tube itself. A double-fluted rubber plug (illustrated) has a hole through the center, is forced through the tube with water pressure and yields a slightly higher cleanliness ratio than simple rubber plugs. A similar plug with bronze scraper attached expands under water pressure to hold the flutes against the tube wall. A positive-spring-loaded scraper plug requires higher water pressure, 100 to 150 lb, and cuts scale and hardened-slime coatings.

It takes from two to three times as long to plug a condenser with scraper plugs driven by water than by rubber plugs and air. Also, provision must be made for cushioning the impact of metal plugs after they leave the tube outlets by hanging a tarpaulin or matting in the water box.

Scraper plugs offer a means of occasional condenser cleaning when a unit has been allowed to get badly coated, for example, to clean a unit preparatory to adopting a chlorinating procedure. Since chlorination is primarily preventive, it is not rapidly effective in improving performance of condensers not previously treated.

The question of damage to tube wall from using scraper plugs once or many times was once considered serious. Continued use in several plants without visible effect on tube life has removed most objections.

Other Cleaning Methods

Sandblasting with air used to be considered a standard method of cleaning a condenser for an acceptance test or during overhaul. While an effective cleaning job results for the first several feet of each tube, it is difficult to clean the center section of long tubes even by blasting from both ends. It is also a long and disagreeable operation.

A modification of this procedure is to force a mixture of flyash, sand and water through the tube at high velocity. Both methods have largely been discarded in favor of scraper plugs, chemicals or chlorination.

Another oldtime favorite largely outmoded is the wirebrush, either at the end of a rod or water driven. Degree of cleaning depends on the stiffness of the wire from which the brush is made.

Boiling out the water side of a condenser requires accurate knowledge of the type of scale or accumulated coating. For compacted slime and oily or greasy deposits, alkaline mixtures specially compounded for the purpose (in a solution of about 2 ounces per gal.) are dependable when held for several hours at about 180 F. Addition of one-half ounce per gal. of cyanide to the solution hastens the action and leaves a brighter finish, but requires expert handling to assure that the solution remains alkaline; otherwise, deadly cyanogen gas is evolved. Care must also be taken in final disposition of the solution to avoid dangerous pollution of the water supply.

TUBES CLEAN

Calcium and silica scales are best removed by an acid solution containing an inhibitor (to minimize attack on the tube metal). Concentrations of such solutions must be maintained by constant chemical testing and should only be undertaken with competent advice and supervision.

Drying out tubes with warm air will often cause thick accumulations to flake and crack off. This procedure involves the risk that the rough surface left by only partial removal of the coating will cause local pits to start and result in early tube failure. Once pitting starts little can be done about stopping its further progress.

The steam sides of condenser tubes accumulate a deposit of boiler compound, rust, and sometimes oil. This deposit interferes with heat transfer rate to a much less extent than does the coating on the water side, because it is usually much thinner and because it is denser and acts less like a heat insulator. If removal of this deposit is considered desirable, boiling out with alkaline solution is effective.

Intermittent Chlorination

In many plants, chlorine or compounds of chlorine are injected into the cooling water ahead of the circulating-water pump for only a small portion of the total operating time. Quantities vary from one to five ppm of chlorine and periods from a few minutes once an hour to a half hour once a day. Several patents cover the different compounds and methods of application.

Most widely used system is intermittent application of chlorine gas obtained from 150-lb or 2000-lb containers under timed automatic control. This requires a chlorinator, rubber-lined solution piping, storage of liquid chlorine in containers, motor-operated solution valves, etc. The installation must be well designed to be safe from escaped chlorine gas.

Quantities of chlorine required are determined by biological examination of the algae growth or by experiment. Two to four ppm of chlorine is usually sufficient. Most such systems operate from three to ten minutes on each circulating-pump inlet every hour or every three hours. Rate of application and period can be adjusted by a simple control at the chlorinator.

Where slime is the principal problem requiring cleaning and where this or other chlorinating systems are effective, condensers do not have to come out of service for tube cleaning. Tube cleanliness can be maintained within a few percent of new tubes.

No authenticated case of reduced tube life resulting from proper methods of chlorination has yet been reported.

Daily Chlorination

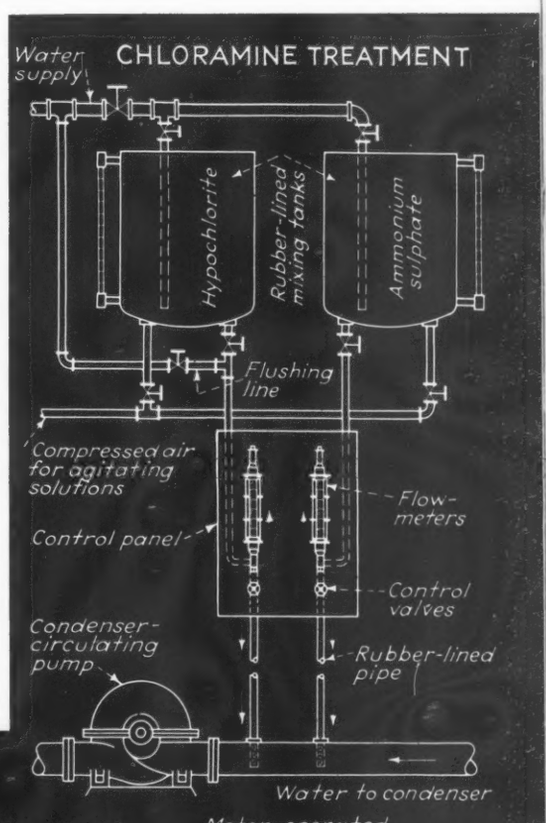
Somewhat increased amounts of chlorine for longer periods has been found effective when applied only once in a 24-hr period. The advantage of this procedure is the elimination of much control equipment and the possibility of using completely safe materials such as sodium hypochlorite (liquid soda bleach) or calcium hypochlorite (bleaching powder). Further, it has provided a means whereby the effectiveness of chlorine treatment can be tried with practically no investment in equipment. In several cases, daily treatment has been found to require less total chlorine than more frequent shorter applications.

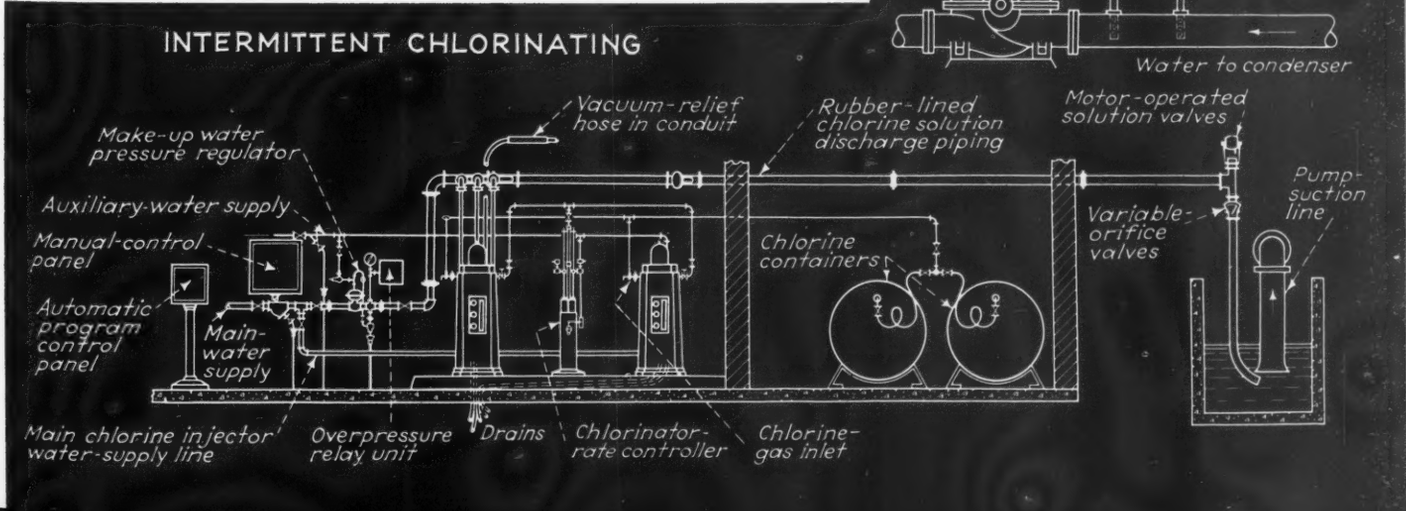
Standard chlorinators can be operated on a daily basis if their capacity is sufficient to furnish the greater amounts of chlorine required.

Two and a half pounds of common bleach powder mixed with about two and a half gal. of water will furnish 3 ppm of available chlorine to 1000 gpm when fed at a uniform rate for one-half hour. Common bleach powder forms a sludge and should be constantly stirred while being fed; it costs about 3 cents per lb. Other stronger bleaching powders that do not form sludge are available at about 50% greater cost per lb of chlorine content.

If the condenser can be taken out of service and the circulating-water valves closed, ¼ lb of common bleach powder will make a solution of 10 ppm strength for each 1000 gal. for soaking the condenser an hour or more. Water and solution should be drawn into the water box and tubes by the priming jets to assure mixing.

A solution ten times as strong as





the above can be used without serious effect on the tube metal. In such proportion it becomes a fairly effective cleaning agent when used daily for two or three weeks.

Another procedure (little used because of possible damage to tubes) is to introduce a few pounds of chlorine gas into the water space of the condenser with the priming jets pulling about 15- to 18-in. vacuum. The gas dissolves partially in the wet slime, effectively chlorinating it. An overdose results in production of hydrochloric acid and rapid tube attack.

Chloramine Treatment

A more recent development is the combination of chlorine and ammonia in dilute solution to form chloramines. Equipment for application is quite simple, but the two solutions (usually bleach powder and ammonium sulplate) must be mixed in separate tanks and fed into the pump suction by separate hose or rubber-lined pipe. When mixed in concentrated solution, the two chemicals form nitrogen trichloride, a poisonous gas.

Chloramines are more selective in their action, that is, they are effective against algae in smaller concentrations than chlorine. In very polluted waters, particularly where sulphides are present, they are effective in small concentration where sufficient amounts of chlorine would be prohibitive in cost. Also, effectiveness of chloramines is not used up as rapidly by the organic matter in the water as is chlorine, offering an advantage where circulating water must be treated some distance from the condenser or for closed systems.

Another development not yet proved in power-plant practice, but hopeful from laboratory investigation is the use of urea-chlorine compounds in the same manner and with the same advantages claimed as chloramines.

Closed Systems

With cooling towers, spray ponds or other recirculating systems, any of the foregoing chemicals are effective when applied continuously, intermittently or periodically in sufficient quantity to maintain the entire circuit in a slime-free condition. In addition, several trade-name compounds are available that can be simply added to the system from time to time to make up for slight losses.

RELANING

» So MUCH has been learned about tube arrangement in condensers that any condenser over ten years old can probably be improved by relaning. Most relaning operations to date have been carried out on large units.

Relaning involves rearrangement of the tubes in the tube sheet either by (1) removing 10 to 30% of existing tubes to form more or wider steam lanes or (2) relocating a number of tubes and changing baffle locations, leaving out 10% or more of the tubes in the process. Most cases reported are of the first class which have required no new material except screwed plugs to cap the holes left vacant in the tube sheet.

The principal object of relaning is to save part of the cost of new tubes when a retubing operation is needed. Not only has this been accomplished in many cases without loss of performance, but an improvement in vacuum has often resulted. Frequently, better deaeration has also been effected in the hotwell and higher condensate temperatures obtained.

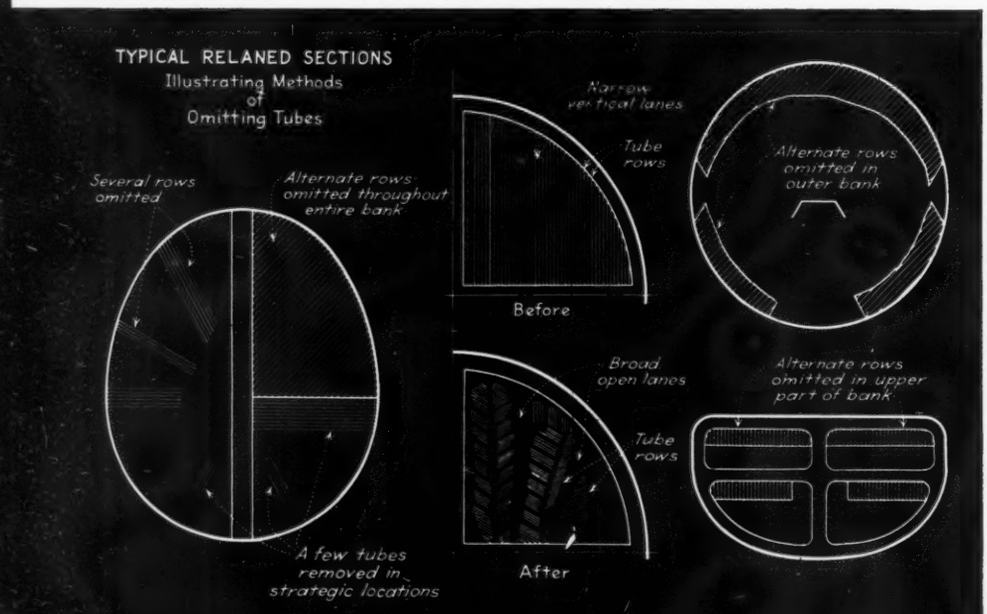
Some time before a condenser is scheduled for retubing, effect of a proposed layout of additional steam laning can be tried out by removing the old tubes in accordance with some suggested pattern. While better vacuum has been the usual result of relaning and the tendency has been to take out too few tubes rather than too many, such an experiment costs little and if results are not satisfactory, a different final arrangement can be settled upon before new tubes are purchased.

Some companies now make a practice of relaning every condenser when it needs retubing. Usual procedure is to compare the existing tube layout with more modern product of the same and other manufacturers and note where deeper or wider steam lanes are used. Most manufacturers have now had considerable experience with relaning and can furnish information for best results with their older designs.

In general, relaning shows best results where the old tube bank is too densely packed. Too close spacing, particularly in the outer part of the bank (first passed over by incoming steam) is more often met in large condensers than in smaller ones where banks do not need to be as deep.

Survey of reports shows that, where a dense tube bank prevents steam getting to inner tubes, generally outer, high-heat-transfer tubes are best removed to get the steam to inner banks with less pressure drop. This is preferable to removing inner, less active tubes. Increased heat transfer of inner tubes more than makes up for loss of outer ones.

Practice follows two general lines, (see Report on Turbines, Condensers and Pumps, EEI, 1937). Either wide, wedge-shaped lanes are formed at the outer edge of the tube bank or alternate rows of tubes are omitted over large sections of the bank. In the latter case, the whole bank uniformly is more open and steam penetrates more deeply. The wedge-shaped lanes apply better where some portion of the inner bank is suspected of being stagnant.



THE OPERATOR'S JOB

» TO RUN A CONDENSER properly, get the best possible vacuum for least use of auxiliary power and steam and to carry on a sound maintenance program, takes more than compressed air and a set of rubber plugs.

First prerequisite to good operating practice is complete familiarity with internal and external workings of the condenser and its numerous auxiliaries, valves and piping.

Starting Up

Putting a condenser in service when new or in routine operation requires a few precautions and a definite sequence procedure. Manufacturers' instruction books contain drawings of the particular equipment furnished by them. To these should be added, at least schematically, all piping, drains and vents that connect to the condenser in any way. This helps in checking for air leaks and possible condensate contamination.

Instruction books also contain information on operation of pumps and air ejectors. As little effect is visible after opening a valve or starting a pump, instruments have to be watched for indication that the desired result has been obtained. Briefly, and insofar as applies to all types of condensers, starting proceeds as follows:

1. Check over the cooling-water circuit to see that trash has been removed from inlet tube sheet and water box, and that all manhole doors and drains are closed. Start water seals on circulating pump glands and see that no other opening exists that can let air into water spaces.

2. Blow down steam supply to priming ejector to remove water and scale from this seldom-used line. Open discharge valve first (if there is one) and see that piping is clear to atmosphere or tunnel. Then open steam-supply valve and check that the steam pressure *at the ejector* is within a few lb of the manufacturer's rating. Then open the suction connection, making sure that upper half of circulating pump will be primed as well as the water-box space. As water rises in system, pump-discharge-pressure gage will show about one inch of vacuum for each foot of water rise above intake level. A thermometer will show a sudden drop when water level reaches it and if water gets to the jets, discharge piping will get rapidly cold.

3. Do not start circulating pump until water level is above top of pump and upper half of casing is full. Water level does not have to reach top tubes, however, if the pump has sufficient head to "throw over" the tail pipe. Head requirement on pump is greater than normal until tail-pipe water leg is established. Start pump and check that flow is normal by reading normal pressure at pump discharge (or difference between inlet and discharge pressure where tide level varies).

4. Start water flowing through aftercondenser of main ejector, either raw water or recirculated condensate. If condensate is used, condensate pump must be started before ejector.

5. Check all openings leading to condenser shell, closing any that might let in air except inter- and aftercondenser drains. Be sure aftercondenser vent is open. Start main ejector by opening discharge and steam supply to *last stage only*. Then open all discharge and suction valves to primary stages. Ejector capacity at low vacuum is greater when primary steam is off. A separate "hogging" ejector of high capacity decreases starting time and eliminates need for starting main jets until condensate is flowing.

6. When vacuum reaches 10 or 15 in. (as prescribed for turbine starting), start turbine. Supply steam to primary jets. When speed is sufficient to make seals effective, open water supply to glands. If vacuum rises too fast, crack vacuum-breaker valve.

7. The condensate pump can be started as soon as there is sufficient water in the gage glass; it should not be run dry. Vent from pump suction to hotwell should be open.

Testing

Vacuum should go up to normal value as turbine speed reaches normal and load is applied. From that time on the problem becomes one of checking performance against known conditions established as correct for the given condenser. This implies that a condenser was tested when new or in good condition and that the results of such a test were equal to or better than manufacturer's expected performance.

Testing a condenser to obtain "bogie" information against which to check normal operation is not as complicated a procedure as is sometimes supposed. An outline for a complete test covering all conditions is, of course, lengthy, and applies principally to acceptance testing where contract stipulations are involved. For this, consult the Test Code for Steam-Condensing Apparatus, ASME Power Test Codes of 1938. This provides for standard determinations of air and cooling-water leakage, duration and frequency of readings, tolerances, instruments, tube-cleanliness measurements and the necessary details for a complete test.

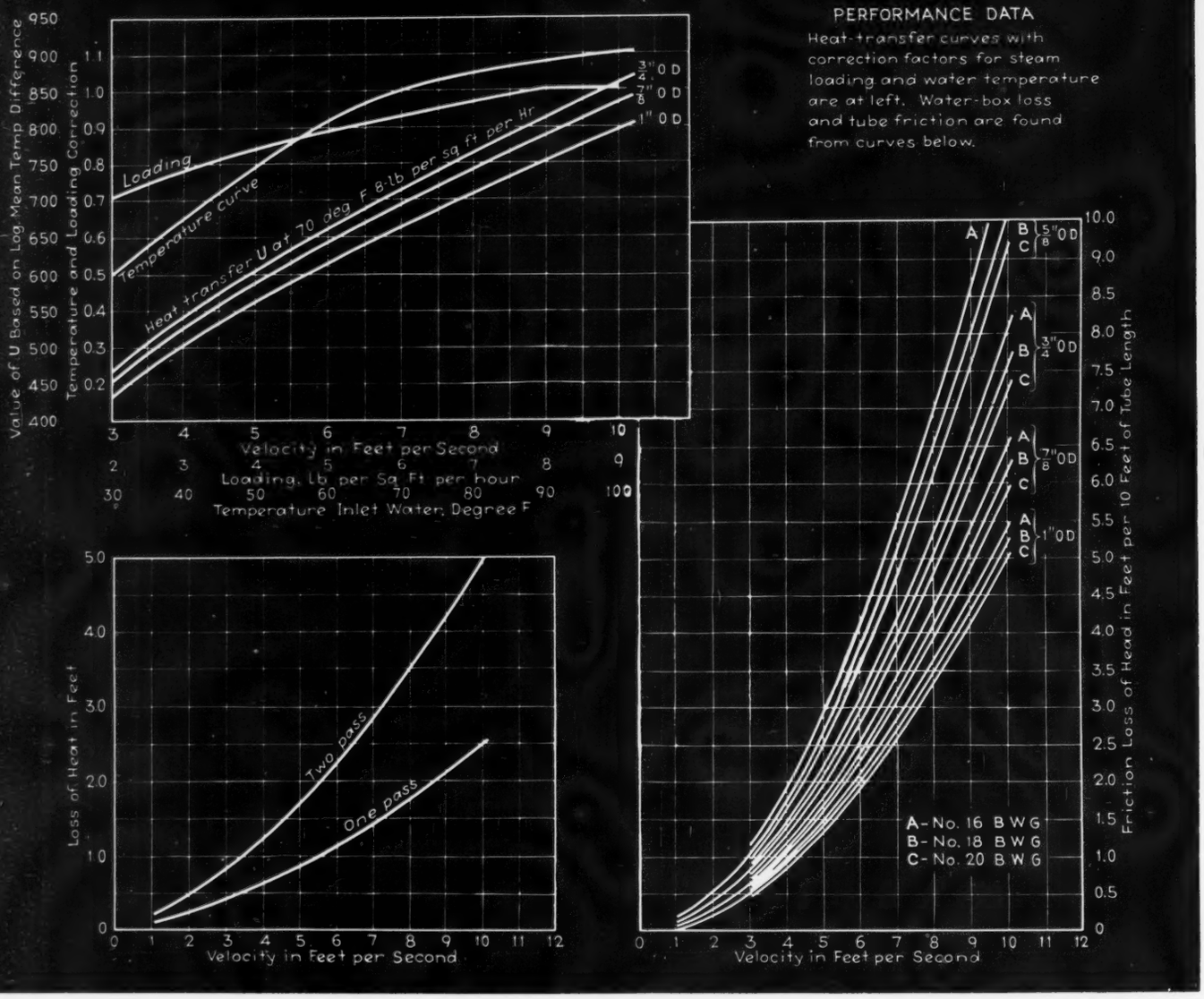
All that is needed for a spot check at a given load (and this can be used indefinitely as "bogie") is careful measurement of the vacuum at the condenser neck, inlet and outlet circulating-water temperatures. Heat rejected by the condenser to the circulating water is usually obtained from the turbine instruction book or calculated for a given set of conditions by the manufacturer. Several other flow and temperature measurements are helpful such as air-leakage flow, air-offtake temperature, hotwell condensate temperature and pressure before and after the circulating pump.

From the water temperatures measured, the logarithmic mean temperature difference can be calculated (see POWER, Jan 1939, Data Sheet 77 and page 89). Heat-transfer rate, Btu per hour per sq ft of condensing surface per degree mean temperature difference can be obtained by dividing the condenser area and MTD directly into the heat-rejection figures for the turbine, being careful to substract heat in the hotwell condensate first.

Before the resulting heat transfer rate can be compared with the manufacturers guarantee (see illustration on following page) or with other operating figures, the water velocity through the tubes must be calculated, usually by the heat-balance method.

Corrections are made for inlet-water temperature, velocity and steam loading from the curves shown. Steam loading is the heat rejected expressed as lb of steam per hr per sq ft of condenser surface. Certain of the manufacturers' catalogues explain these computations in more detail and give constants and short-cut methods.

After the best the condenser can do is once established, it is good practice to keep daily or at least periodic records. Performance falls off due to dirty tubes, trash on the inlet tube sheet, increased air leakage, etc. This change may be quite gradual and only


PERFORMANCE DATA
Heat-transfer curves with correction factors for steam loading and water temperature are at left. Water-box loss and tube friction are found from curves below.
Value of U Based on Log Mean Temp Difference
Temperature and Loading Correction
Loading
Temperature curve
Heat transfer U at 70 deg F 8-Lb per sq ft per Hr
3/4" O D
7/8" O D
1" O D
Velocity in Feet per Second
Loading, Lb per Sq Ft per hour
Temperature Inlet Water, Degree F
Loss of Heat in Feet
Two pass
One pass
Velocity in Feet per Second
A
B
C
5/8" O D
3/4" O D
7/8" O D
1" O D
A- No. 16 B W G
B- No. 18 B W G
C- No. 20 B W G
Friction Loss of Head in Feet per 10 Feet of Tube Length
Velocity in Feet per Second

a consistent practice of log-keeping will show it up. (See POWER, Jan 1939, page 89 for form.)

These records can be used to determine frequency of tube cleaning, justification for chlorinating and, if nothing else, to assure an operator that his condenser is doing all that can be expected of it.

When Vacuum Is Low

No matter what goes wrong with a condenser installation, low vacuum results. This means all the things that can go wrong have to be checked every time vacuum falls below par, another good reason for establishing a base performance for everyday comparison.

First, and unusual, if a condenser suddenly "goes atmospheric", that is, blows steam out the atmospheric relief line, drastic measures are in order to get the turbine off the line as quickly as possible. Trouble is usually lack of circulating water due to failure of pump drive. Divided water-box systems reduce the probability of such an occurrence.

A fall-off in vacuum either gradual or sudden under normal load and water conditions is usually traceable to (1) increased air leakage (2) tube-sheet fouling or (3) tube scale or slime accumulations.

Air leakage should normally be from 2 to 7 cfm regardless of size of condenser unless excessive amounts of air are brought to the condenser unavoidably in vents and drains. Normal leakage should be established by test after first filling all steam spaces with water and correcting leaks and with all possible external connections closed off. One-by-one opening of vents and drains should not increase leakage above values given; if one connection indicates high leakage, piping joints and connected equipment should be checked until the leak is found.

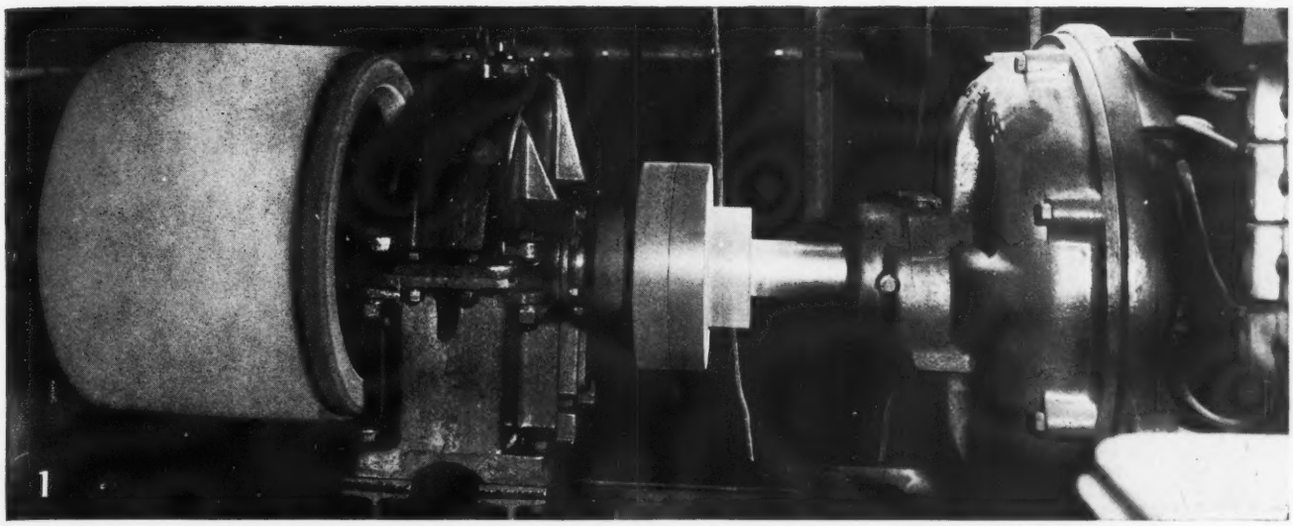
One check for normal air leakage that does not require some form of metering device, is to close the suction valve to the primary jets gradually, watching the vacuum column for any rapid change. Unless air leakage is excessive, vacuum should not fall off more than an inch in ten minutes.

More than normal subcooling of the condensate below inlet-steam temperature is one indication of increased air leakage. The same result is produced by plugging of air-ejector jets.

Low water quantity shows up by increased circulating-water-temperature rise at normal load and pump operation. Trash, leaves or fish on the inlet tube sheet can greatly reduce water flow. A new device, illustrated on page 68, permits reversal of flow to wash away trash. Water jets pivoted on ball sockets can also be incorporated in manhole covers.

Slime and scale formations are periodic and usually predictable in their occurrence. Only a study of the cost of cleaning, the value of extra coal burned because of low vacuum and a comparison of other possible methods of tube cleaning can determine best procedure.

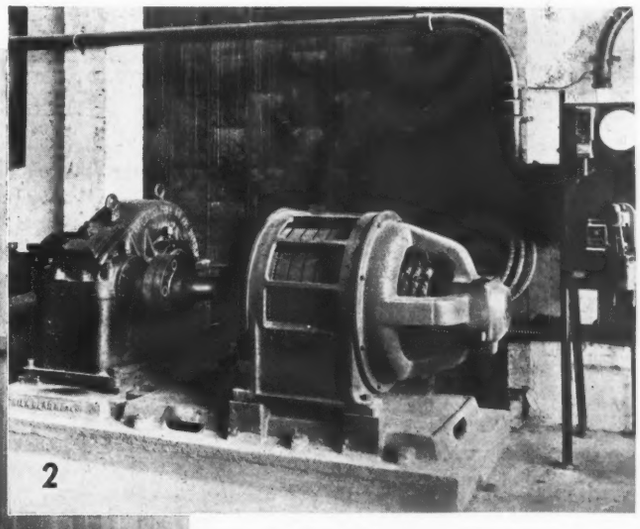
Leaking tubes, at packings or due to corrosion pits, shows up quickly when the circulating water is sea water containing salt. A conductivity meter measures electrical resistance of condensate and gives indication of amount as well as presence of leakage. A simple chemical test can also be carried out that indicates approximate amount of leakage.



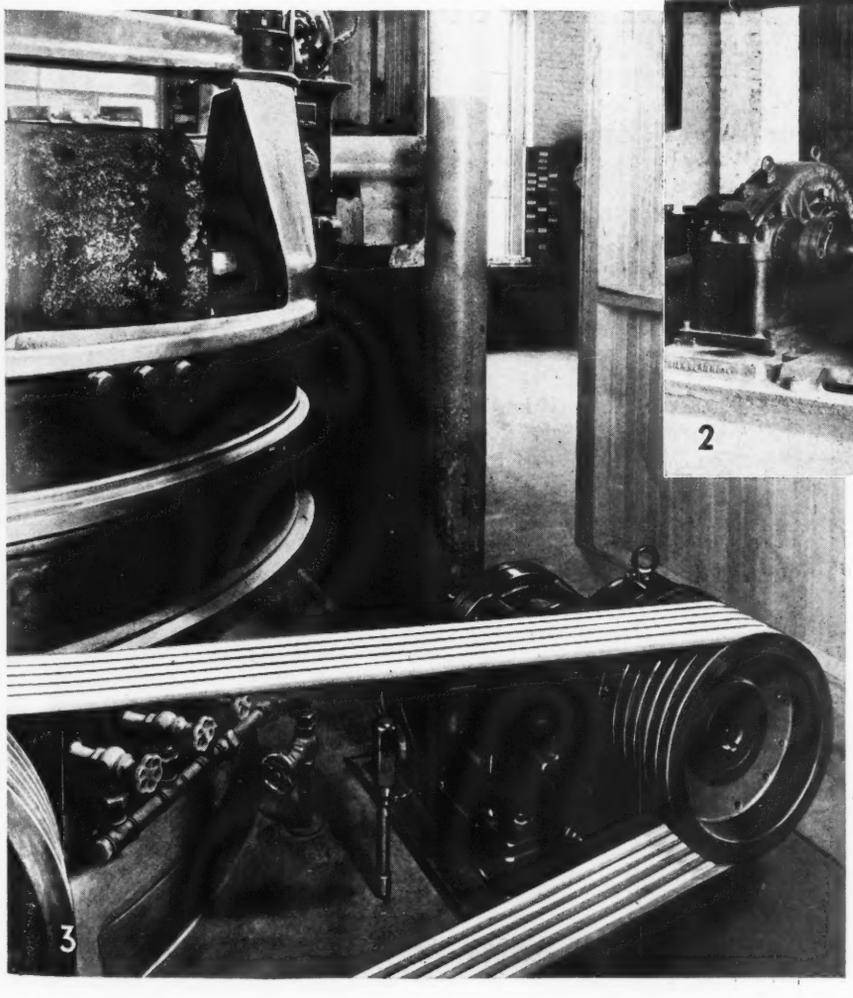
1. A Westinghouse gear speed-reduction unit and flat belt connect 50-hp wound-rotor motor to mill line shaft. Bearing for belt drive, gear unit and motor are mounted on structural-steel base

In High Gear

The power engineer needs many ways of distributing his product, using mechanical-transmission equipment in a wide range of applications



2. 150-hp, 1200-rpm, wound-rotor motor drives line shaft in an asphalt plant through a Philadelphia herringbone gear reducer. Gear ratio is 4.5 to 1



3. 15-hp, 1750-to-495-rpm Allis-Chalmers gear motor (gear ratio 3.5 to 1) connected to chocolate mixer by V-belts, ratio 1.5 to 1

(Continued on page 80)

Modern Boiler

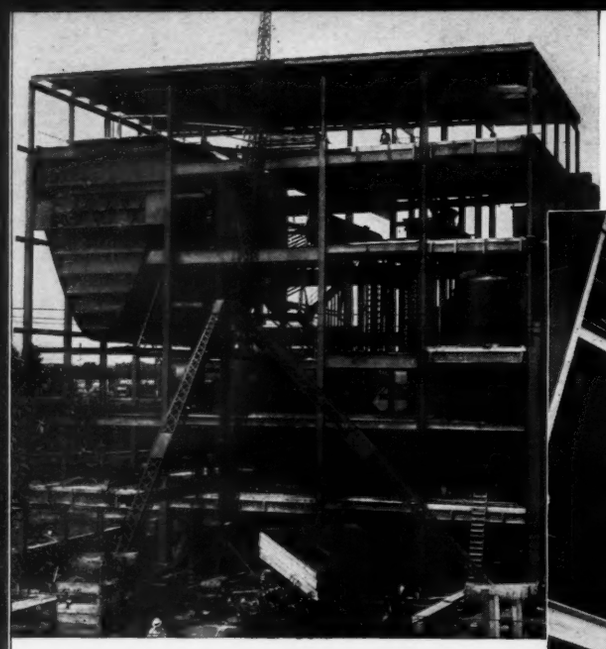


Figure 1—New Riley Boiler being installed for Columbus Municipal Light plant, Columbus, Ohio. This unit will generate 150,000 lbs. of steam per hour. Unit consists of Riley Boiler, Superheater, Water-cooled Furnace, Economizer, Air Heater, Steel Clad Setting, fired by Multiple Retort Stokers.

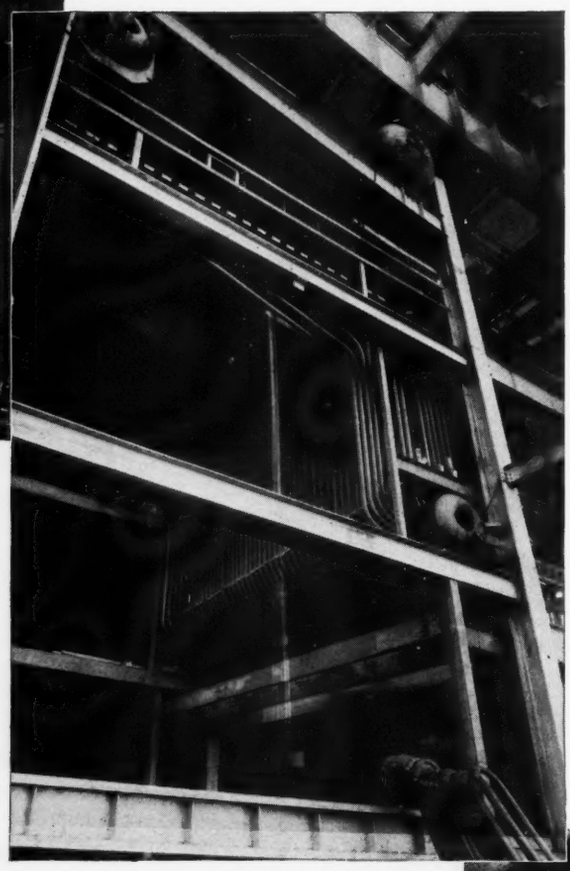


Figure 2—New Commonwealth & Southern Unit of Central Illinois Light Plant, Peoria, Ill. This unit has just been placed in operation. It generates 300,000 lbs. of steam per hour. Design pressure 900 lbs. A steam temperature of 875° F. is held constant by an unique steam temperature control. The same temperature control is also used at the Otter Tail Power Company's installation. See Fig. 7. Boiler, Superheater, Superheater Temperature Control, Water-cooled Furnace, Economizer, Air Heater, and Steel Clad Setting furnished by Riley Stoker Corporation.

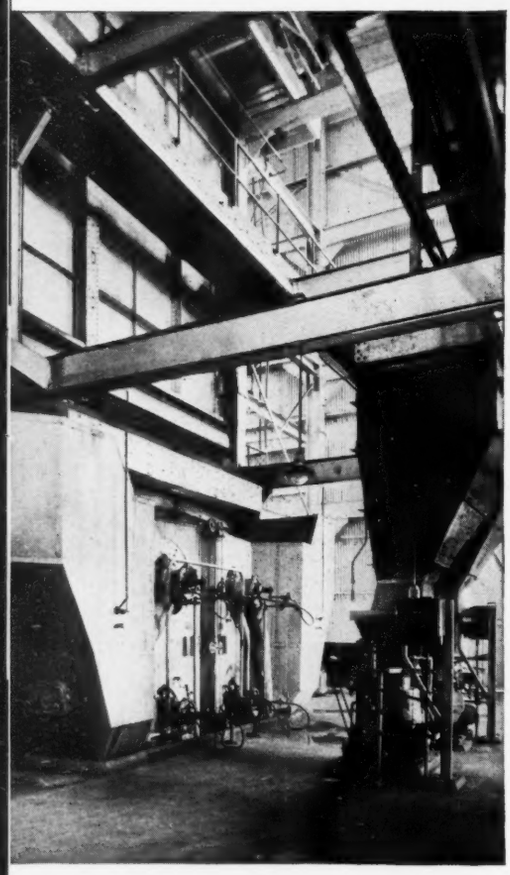


Figure 3—At their new plant at Charleston, S. C., West Va. Pulp & Paper Co. have recently placed in operation 2-225,000 lbs. per hour Riley Steam Generating Units. Units operate at 600 lbs. pressure and 750 degrees temperature. Boilers, Superheaters, Water Walls, Air Heaters, Pulverizers, and Burners by Riley Stoker Corp.

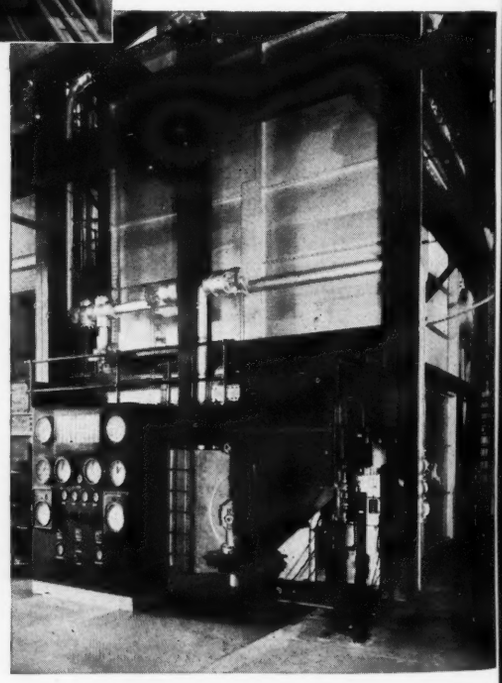


Figure 4—The latest extension of the University of Minnesota consisted of a 100,000 lb. per hour Riley Steam Generating Unit. This unit includes Riley Boiler, Water-cooled Furnace, Air Heater, Steel Clad Setting, Fired with Riley Pulverizers. Unit operates at efficiencies over 85%.

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

Installations

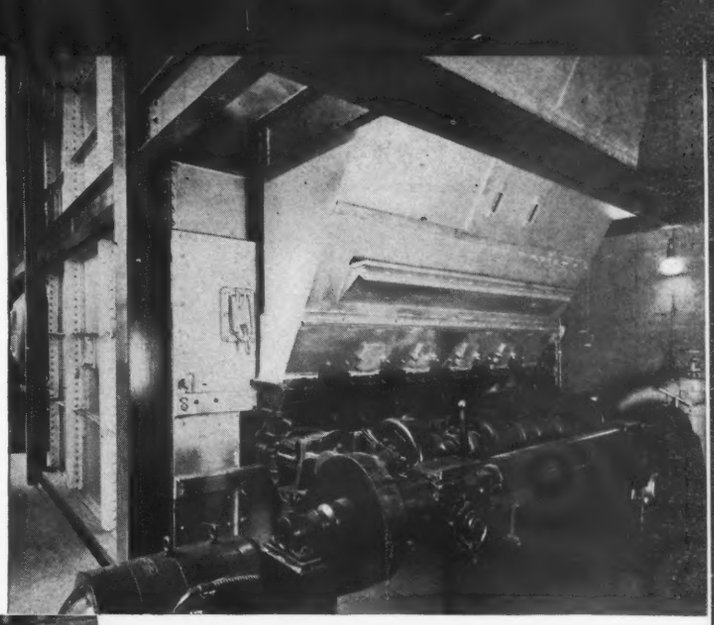


Figure 5—City of Detroit Lakes, Minn. An excellent example of a low cost, efficient unit. Due to low load factor and other considerations, studies by the consulting engineer, Mr. Chas. Foster, indicated that higher commercial efficiency would be obtained from a unit without heat recovery equipment. This 50,000 lbs. per hour unit, consisting of Riley Boiler, Superheater, Water Walls and Steel Clad Setting fired by Riley Multiple Retort Stoker operates at efficiencies over 80%. Fuel Economy Engineering Corporation, St. Paul, Minn., General Contractors.

Figure 6—In order to prevent air and gas leakage, the settings of many modern boilers are totally encased in a steel casing. This photograph shows what an excellent job the Riley Stoker Corporation does in encasing their boilers. This setting is not only tight when the installation is new but stays tight after years of service. Note Figure 7 for side and front steel casing for this unit.

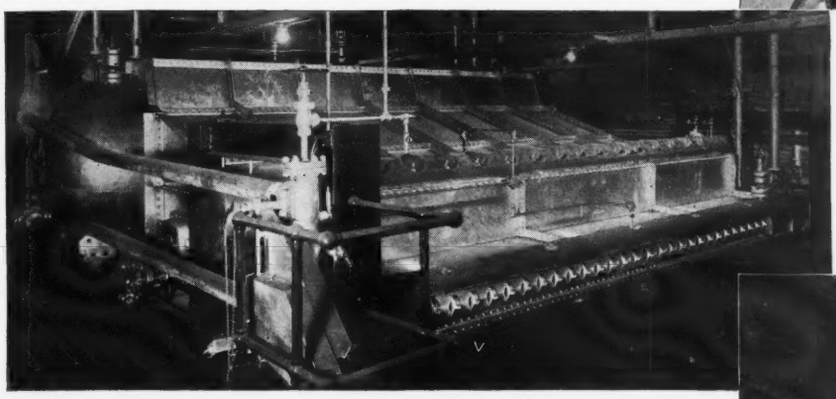
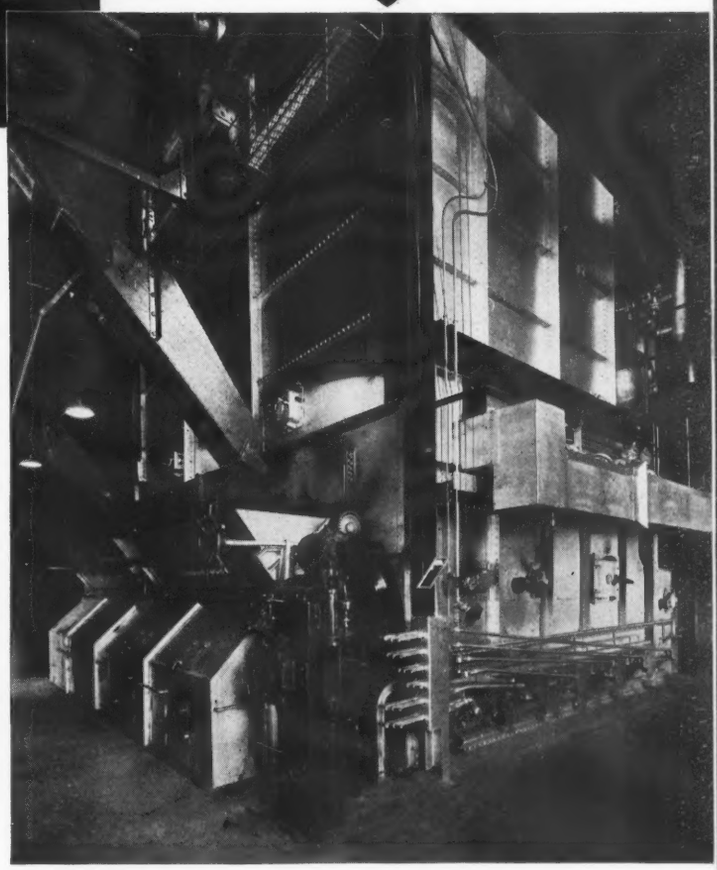


Figure 7— This unit of the Otter Tail Power Company's Wahpeton, N. D. plant is the country's outstanding lignite burning installation. 40% moisture lignite is burned at efficiencies over 82%. The unit consists of Riley Boiler, Superheater, Water-cooled Furnace and Arches, Air Heater, Economizer, and Harrington Traveling Grate Stoker. The unit is designed for a capacity of 130,000 lbs. of steam per hour at 600 lbs. pressure and 825° F. steam. Fuel Economy Engineering Corp., St. Paul, Minn., General Contractors.



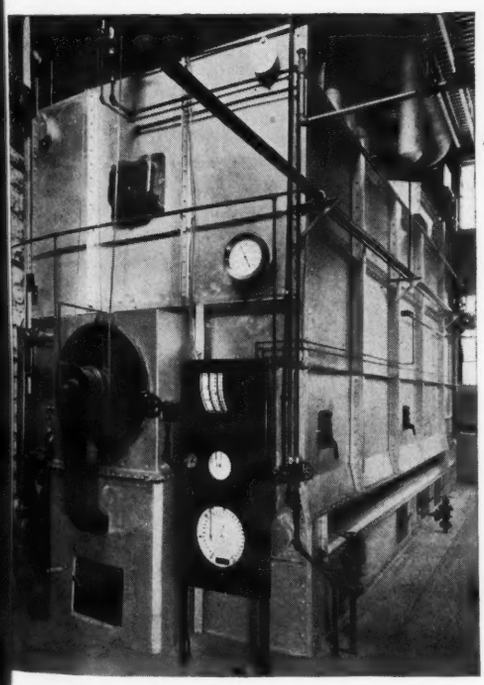


Figure 8—This photograph shows a 25,000 lbs. per hour Riley "RO" Unit installed in Rochester Dairy, Rochester, Minn. Efficiencies of over 80% are obtained from this gas fired unit. This unit with Water-cooled Furnace, Economizer, and Steel Clad Setting has many of the operating advantages of the large steam generating unit. Because of its many distinctive advantages, this type of unit is rapidly taking the place of low head and H.R.T. types of boilers.

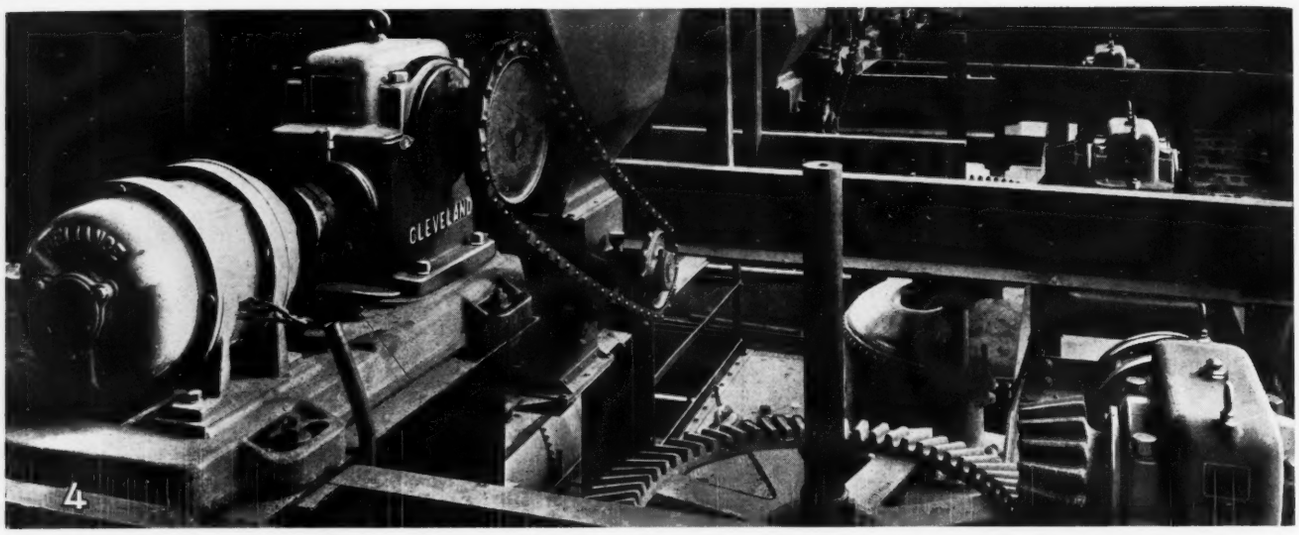
A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

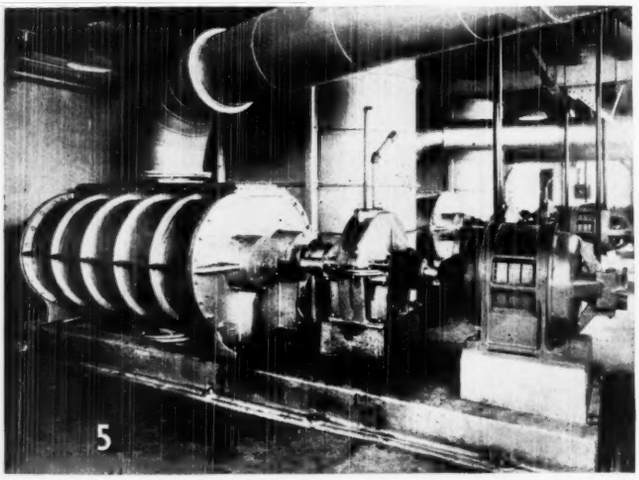
BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

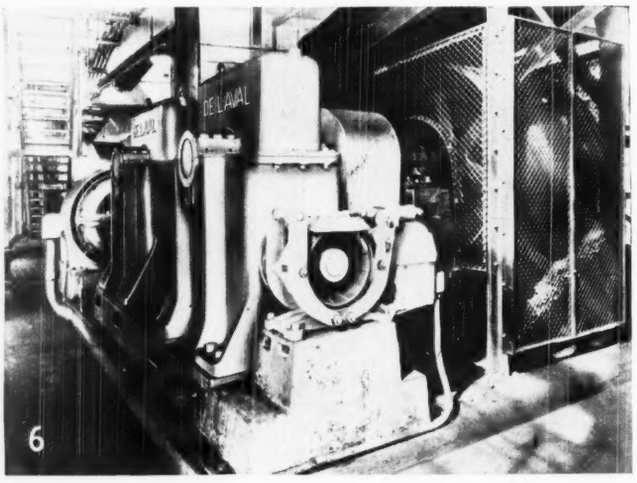
(Continued from page 77)



4. Three 5-hp, 1160-rpm squirrel-cage motors drive screw conveyors through Cleveland worm-gear reduction units and roller chains (gear ratio 19.5 to 1) and three 10-hp, 1160-rpm squirrel-cage motors are connected to vertical devulcanizers by worm-gear units and beveled gears, in a rubber-reclaiming plant

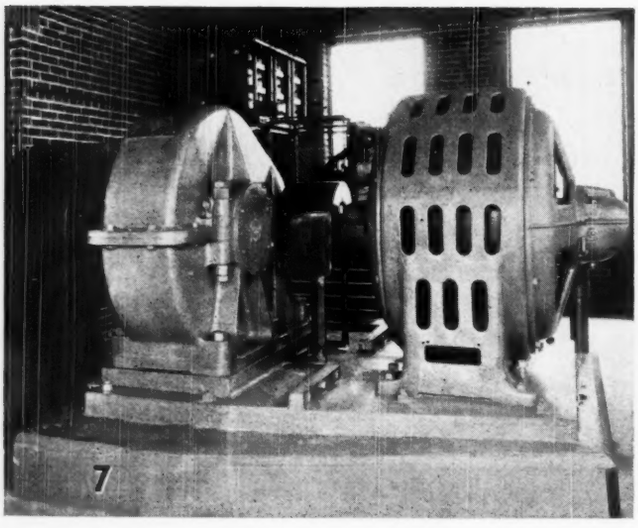


5. Falk gear reducers step down speed from 75-hp, 1160-rpm motors to three roller-bearing Roots blowers, of 9750-cfm free-air capacity against 1.5-lb discharge pressure at 204 rpm

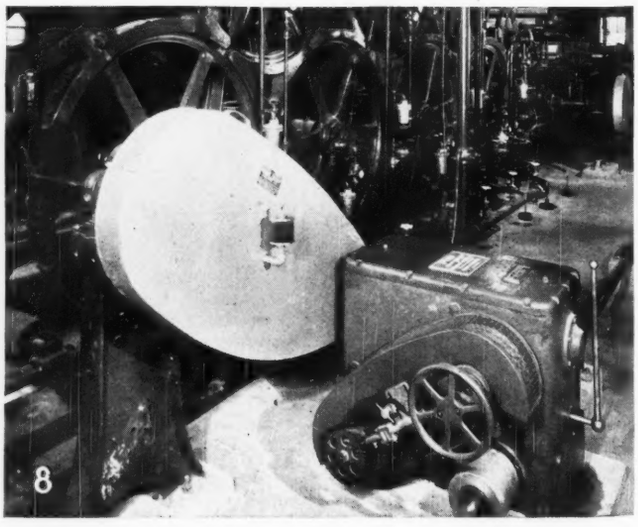


6. A tandem-drive belt conveyor in a power-plant coal-breaker house driven by a 150-hp, 720-rpm wound-rotor motor through two 29.5-to-1 ratio De Laval worm-gear speed reducers

7. Coal-mine fan at Glen Alden Coal Co, Wilkes-Barre, Pa., driven by 500-hp, 900-rpm motor through Link-Belt single-reduction herringbone speed reducer, gear ratio 7.22 to 1



8. Morse-Chain paper-machine drive combines in one casing a hypoid gear, chain drive, clutch for convenient stopping and starting, and a variable-speed V-belt drive



Heat Pumps Serve New Coast Building

Refrigeration equipment for summer cooling supplies winter heating by reversed-cycle operation at Westinghouse building in Emeryville, Calif.

REVERSING the refrigeration cycle, so that the same equipment can be used for both cooling and heating, is not a new idea, but serious engineering study of "heat pumps" really dates from the time the low-cost mechanical refrigerator began to click. Since then the reversed cycle has been studied and discussed, but only a few installations have been made. Thus, there is considerable interest in the reversed-cycle year-around conditioning plant installed at the new Westinghouse building in Emeryville, Calif.

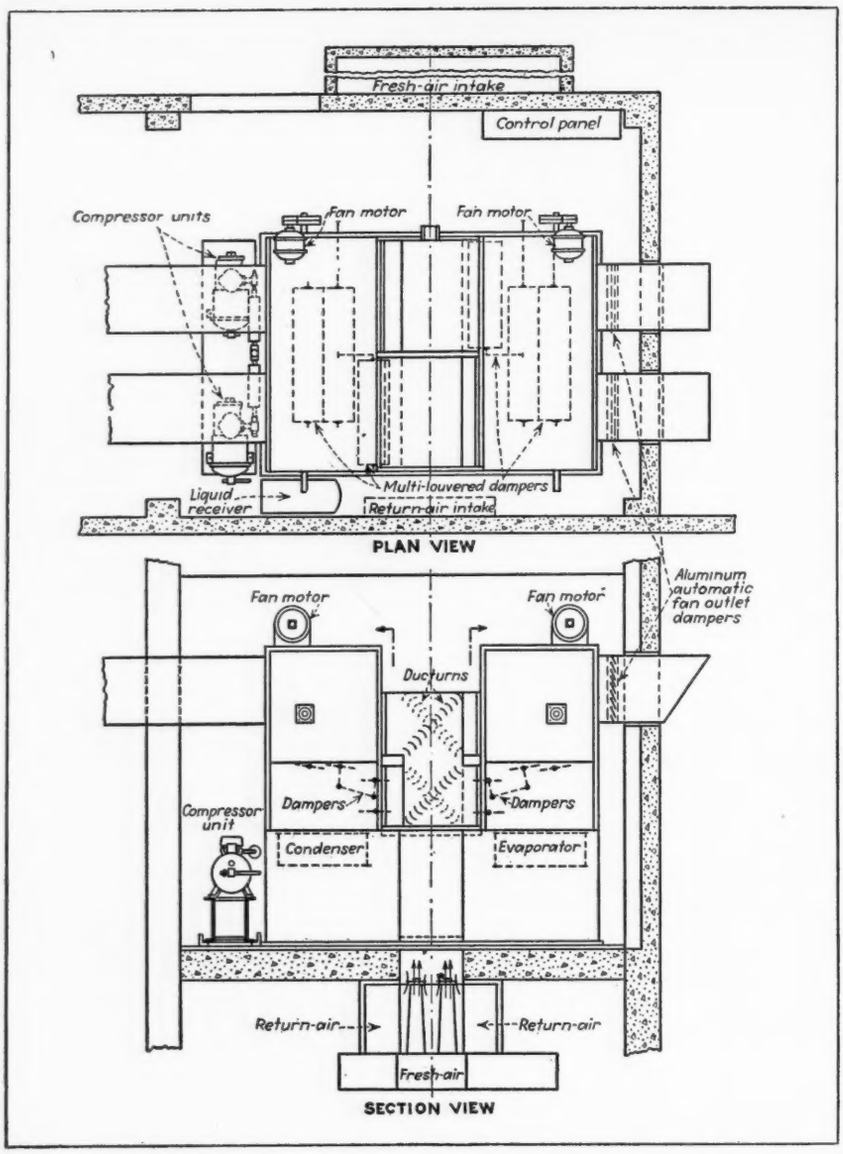
This system completely conditions a building 90 ft long, 50 ft wide, and two stories high, with 6-in. concrete walls, and roof insulated with 4-in. redwood bark. Designed for either manual or full automatic operation, the equipment, consisting of two 7.5-ton condensing units, with associated fans, ducts and dampers, heats or cools, humidifies or dehumidifies, and circulates 16,000 cfm. Estimated cooling load is 196,000 Btu, and estimated heating is 238,400 Btu, based on 35 F outside and 70 F inside.

Best idea of the working of a reversed-cycle system can be had by looking at the average domestic mechanical refrigerator. To maintain a lower temperature inside the box than in the surrounding room, heat leakage into the box must be reduced by insulation of the walls, and heat that does leak in must be carried away. Since all the surroundings are at a higher temperature level, heat must be pumped out. To put it another way, in the box, heat must be transferred from air to evaporator at low temperature, while outside the box heat must be transferred from the condenser to the surrounding air, at a much higher temperature. The trick of making heat run up hill depends on the well known fact that boiling point of liquids depends on pressure. Refrigerant vapor, raised to a high pressure in the compressor, is changed to a liquid in the condenser, the transfer of heat taking place at a fairly high temperature due to high pressure. The high-pressure liquid then passes through an expansion valve which lowers the pressure, making it possible for the liquid to vaporize, or boil, at a low temperature. Latent heat needed to change the state of the liquid comes from the air surrounding the evaporator coils inside the box. The low-pressure vapor then returns to the suction of the compressor, and the cycle is repeated.

To summarize: by supplying mechanical work at the compressor it is possible to absorb heat at low temperature and discharge it at a higher level. Heat absorbed in the evaporator is the refrigerating effect; heat rejected in the condenser is the refrigerating effect plus the heat equivalent of the work done at the compressor. Efficiency of a refrigerating plant is expressed as coefficient of performance, which is the refrigerating effect divided by the heat equivalent of the mechanical work. This gives a value greater than 1; coefficients of performance commonly run in the neighborhood of 5 to 10.

To picture the use of refrigerating equipment for heating, put the evaporator coils outside the box, and the c ndenser inside. Remember also that the inside of the box is to be kept warmer than the air in the surrounding room. It can be seen that the essential arrangement is the same as before; heat is being transferred into the refrigerant at the evaporator, at low temperature, and out of the refrigerant in the condenser at high temperature.

Mechanical application of refrigera-

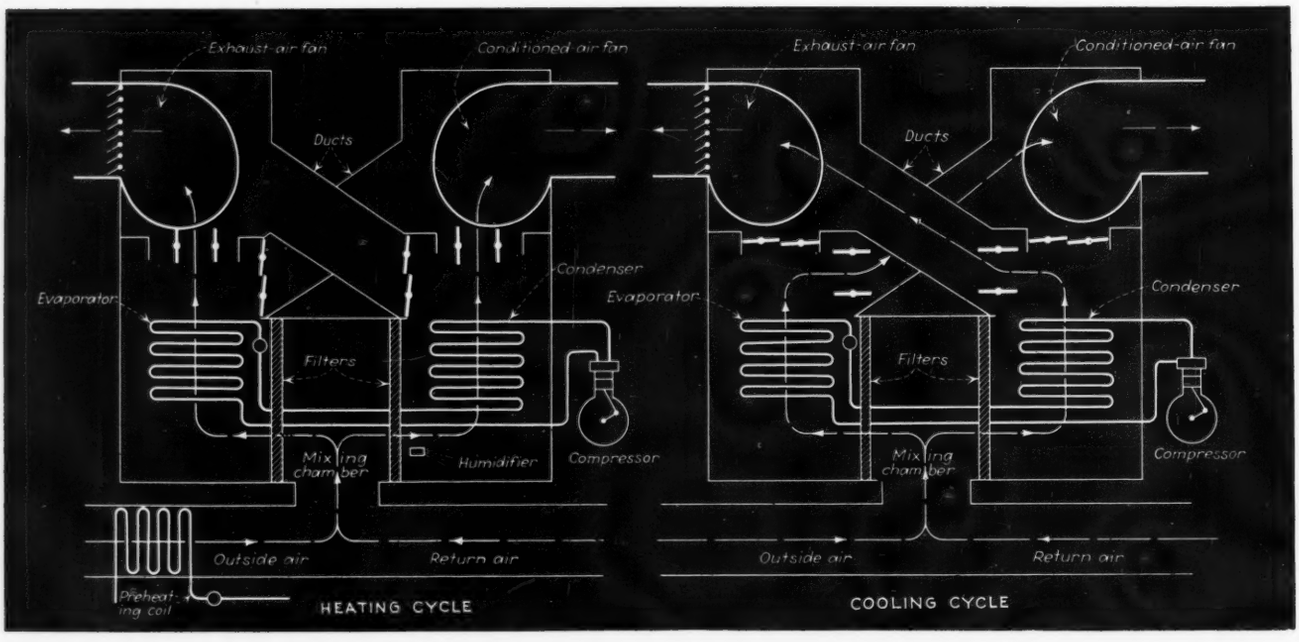


Plan and section of housing for conditioning equipment

tion equipment to year-around conditioning by the reversed-cycle is essentially simple. Duct connections and dampers are arranged as shown in the sketch, which represents schematically the set up in use at Emeryville. Fresh air and return air mix in about even proportions, divide into two streams, each passing through filters. In summer months when cooling is required, one stream flows around the evaporator coils and, after being cooled, is forced by the conditioned-air fan to the duct system supplying the building. The other air stream carries away heat from the condenser coils and is blown out of doors by the exhaust fan. For winter heating it is only necessary to change position of the dampers so that air going to the conditioned-air fan flows around the condenser rather than the evaporator; picking up heat, rather than losing it. Similarly, the other air stream passes through the evaporator section, giving up heat before passing outdoors through the exhaust fan.

Economics Decide

Success of such an application depends, however, on thermal and economic considerations, rather than on mechanical design. Reversed-cycle conditioning works best where differences between summer and winter weather conditions are not extreme; that is, where the equipment needed for summer cooling is nearly adequate for winter heating. Where cold winters are common, the refrigerating plant must be considerably larger than would be necessary merely for summer cooling. A point is soon reached where the capital cost of equipment exceeds that



Diagrams illustrate operation of reversed-cycle conditioning system

for conventional conditioning systems and the advantages of reversed-cycle operation disappear. This factor limits successful application of this conditioning method to certain fairly well defined climatic areas.

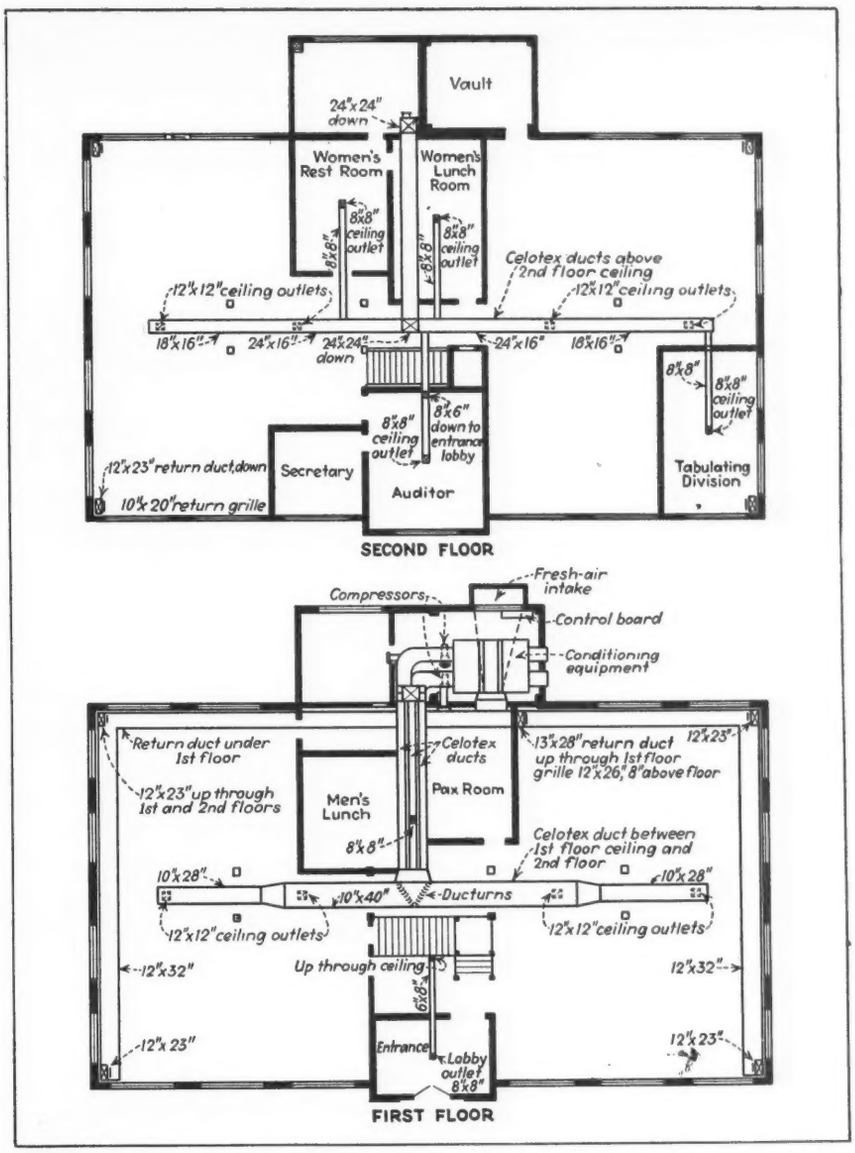
Where conditions are favorable for reversed-cycle conditioning, another economic balance must be struck. Referring back to the coefficient of performance mentioned before, it will be seen that when used as a heating unit the reversed-cycle plant will deliver many times the heat equivalent of the mechanical or electrical energy supplied. This, of course, is why it is feasible to consider heating with electricity.

Heating Cost

With outside air at 35 F and delivering air from the unit at 90 F, the theoretical coefficient of performance would be 10, which means that for every kilowatt-hour supplied to the compressor, 34,150 Btu would be delivered to the building. Getting 10 kw-hrs for the price of one puts even high-cost electricity on favorable terms with fuels used in conventional heating systems. However, to approach the theoretical coefficient of performance requires extremely large heat-transfer surfaces to reduce terminal difference and so make nearly full use of the available temperature range. Such a plant would reduce operating costs but would involve heavy capital investment. At Emeryville, the balance was struck at a coefficient of performance of about 5 to 1, which gave a heating cost, based on electricity at one cent per kw-hr, comparable to a natural gas or oil-fired heating system.

For outdoor temperatures below the 35 F used as a design figure, a preheating coil is provided. A thermostatically-controlled valve operates when air temperature in the fresh air duct drops below 35 F, admitting city water to the coil. Since water temperature runs about 60 F, air picks up heat and enters the evaporator at a temperature sufficient to permit evaporator operation above the freezing point, preventing frosting on evaporator surfaces.

General layout of the air-conditioning system at Emeryville is shown in the floor plans. Refrigeration equipment, fans, and main dampers are in a room at the rear of the building, on the ground floor. Fresh air enters through the intake shown and mixes with return air in a chamber below the conditioning unit, before passing into the conditioner. Conditioned-air ducts run as indicated, those serving the first floor being between ceiling and second floor,



Floor plans show location of conditioning equipment, supply and return ducts

those serving the second floor being between ceiling and roof. Return-air grilles in the corners of the second floor connect with riser ducts leading to the main return-air ducts under first floor.

Equipment in the air-conditioning room is standard, modified to meet special conditions of this installation. Two 7.5-ton hermetically-sealed Westinghouse compressor units, operated in parallel, are mounted to one side of the housing enclosing the evaporators, condensers, and fans. The plan and section shows the housing, built at the Emeryville shops, and the disposition of the equipment. Design of the fresh- and return-air connection produces an aspirating effect, giving some mixing of fresh and return air before entrance into the mixing chamber.

The condenser shown is a standard evaporator section reconnected to form an 8-row coil. Fans are driven by 3-hp, 1690-rpm motors, with adjustable-pitch motor sheaves for changing fan speed. With a 7.5-hp motor on each compressor, and 3-hp on each fan drive, the total comes to 21 hp.

Automatic outlet louvres in discharge connections to the exhaust fan open when the fan is in operation and close automatically when fan stops. As the exhaust fan operates only when the compressors are in operation, these dampers prevent outside air being drawn through this section into the conditioned-air fan. Switching or transfer dampers are linked together and operated by a damper motor.

Five water-atomizing nozzles in the compartment under the condenser add moisture under control of a humidostat located on the first floor. Dry filters are located on either side of the air-mixing chamber at the entrance to the condenser and evaporator sections. Doors give access for cleaning and renewal.

Steam—Buy the Standard Pound

Accounting for steam in a plant with several pressure levels, tops, condensing turbines and process use, is like trying to add apples and potatoes. Simple charts convert all heat to "standard" steam with minimum corrections and maximum convenience

By FORREST L DUFF
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HIGHER STEAM PRESSURES and temperatures superposed on older equipment create a need for a convenient common denominator to compare efficiency and performance of steam generators and prime movers operating at several temperature and pressure levels within a single plant. Also where steam is used for process or heating, some convenient method is needed to arrive at an accounting charge for these services.

To make comparisons and charges on a Btu basis entails lengthy calculations. An "equivalent" or "from and at 212 F" basis is a wide departure from actual conditions and actual figures differ from the equivalent so much that operating crews and accounting personnel have to think and talk two values.

A most convenient unit would be one practically equal in value to operating figures, and at the same time accurate for accounting figures. This unit can appropriately be called "standard" steam, and 1000 pounds of this standard steam is an extremely convenient accounting unit. The Btu value of this standard steam can be fixed and charts may be prepared to simplify daily and monthly calculations for a given plant. An illustration follows.

Suppose in a moderate-size industrial station steam generators operate at 150 lb, 240 lb, and 675 lb, g; prime movers operate at 650-lb throttle pressure and 150-lb exhaust, 240-lb condensing, 150-lb condensing, and 150-lb throttle to 50-lb exhaust pressure; steam is supplied to various processes and heating systems at 150-lb pressure in all cases except one 50-lb service which consists of the exhaust of one prime mover plus a reducing-valve makeup from a 150-lb line. The distribution system meters steam at 150 lb. Nominal temperature in the distribution system is 100-F superheat or 466-F total temperature.

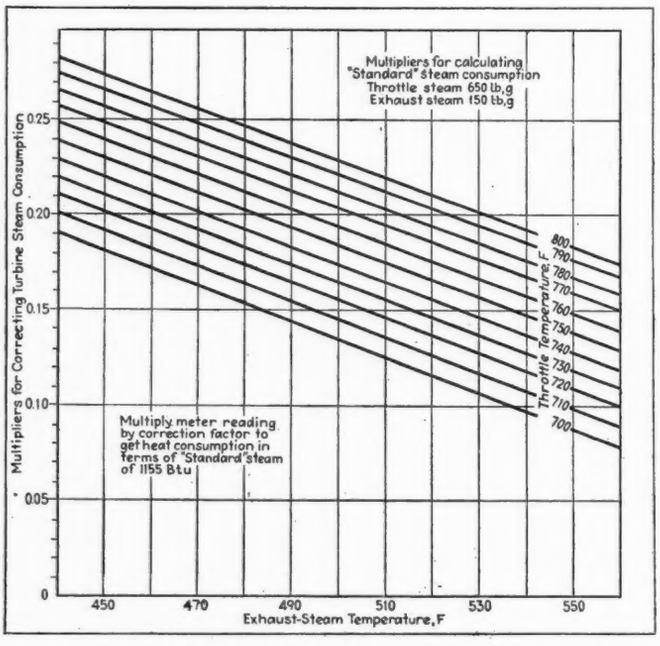

Fig. 1—A chart like this for each non-condensing prime mover where exhaust is used, gives heat consumption in standard steam

From the above description it is evident that the great majority of steam metering in such a plant takes place at 150-lb g, 466 F. If this state of steam is fixed as standard, exceptions will be a minimum, requiring fewest corrections, and the majority of charges will be on an "as read" basis.

A study of operating records shows the weighted annual average raw-water-makeup and condensate-return temperature to be approximately 130 F. The heat required to generate steam at 150 lb g, 466 F from water at approximately 130 F is the desired Btu value for a standard steam since it will correspond to average operating conditions and the number of variations will be held to a minimum.

Heat Value

The enthalpy (total heat above 32 F) of steam at 150-lb gage pressure, 466 F, is 1254.74 Btu, and the enthalpy of water at 130 F is 97.86 Btu. Heat required per pound of standard steam, then, is 1254.74 less 97.86, or 1156.88 Btu. Since 1156.88 Btu is an odd figure and would prove clumsy to use as a calculating basis, 1155 can be the heat value of standard steam, and the water temperature corresponding to this heat value and steam at 150 lb g, 466 F, becomes 131.88 F.

A value for standard steam having been selected, short-cuts in calculations can be found in simple charts to convert actual steam flow at various conditions to standard steam. Fig. 2 is a nomogram from which a factor "C" can be read directly by connecting the water-temperature scale to the steam-temperature scale at proper pressure and temperature by a straight line and reading the multiplier "C" from the middle scale.

This nomogram will give values of "C" for all three operating pressures and varying steam temperatures accounting for respective feedwater temperatures; the 240-lb and 150-lb prime movers operating condensing; and the correction factor for adjusting process steam either daily or at the end of the accounting period, based on actual steam, makeup, and condensate-return temperatures. Special cases in the distribution system where all steam is released to atmosphere and requires 100% raw-water makeup at the boiler house, or where

all condensate is returned and requires no raw-water makeup can be dealt with by simply using a separate factor "C" for these services, rather than using the factor based on average makeup and returns temperatures.

A nomogram like Fig. 2 can be constructed from the simple formula:

$$C = \frac{1155 + A + B}{1155}$$

where 1155 is the assumed net heating value for standard steam, *A* is heat content of feedwater for standard conditions, *B* is heat in actual steam less heat in standard steam. The resulting equation can be worked around until it is in the general form $x + y = z$ which plots as a nomogram with three vertical straight lines.

Separate Charts

Each of the non-condensing or back-pressure prime movers requires a separate chart, which can be in the form of a nomogram, but is simpler to construct as in Fig. 1, which is drawn for a 650- to 150-lb unit.

To bring calculations down to an absolute minimum, the meter constant, temperature correction on the meter orifice or nozzle, and ratio of actual

$$\frac{\text{Btu/lb steam}}{\text{1155 Btu/lb steam}}$$

are combined into one multiplier for any combination of throttle and exhaust-steam temperatures. Variations in pressure can usually be safely neglected in ordinary operation so far as heat values are concerned, but the pressure correction for the meter (charts from meter manufacturer) should be considered for accuracy of steam quantity. This is taken care of by multiplying the pressure correction for the meter at *design* temperature by the factor from the chart (Fig. 1) at *actual* temperatures and multiplying this product by the meter integrater difference for the desired period.

To illustrate the calculation of Fig. 1, a point for 730-F steam and 470-F exhaust is found by multiplying together three factors:

(1) $\frac{\text{Meter constant}}{\text{1000 lb}} = \frac{1000}{2000} = 2$

(2) Temp correction on nozzle = 1.01

(3) $\frac{\text{Throttle heat} - \text{heat in exhaust}}{\text{1155 Btu}}$

$= 0.0946$

The required multiplier, the product of three factors, is 0.191.

A theoretical standard steam rate for prime movers is also a convenient tool and makes thermal efficiency calculations easy.

(Continued on page 126)

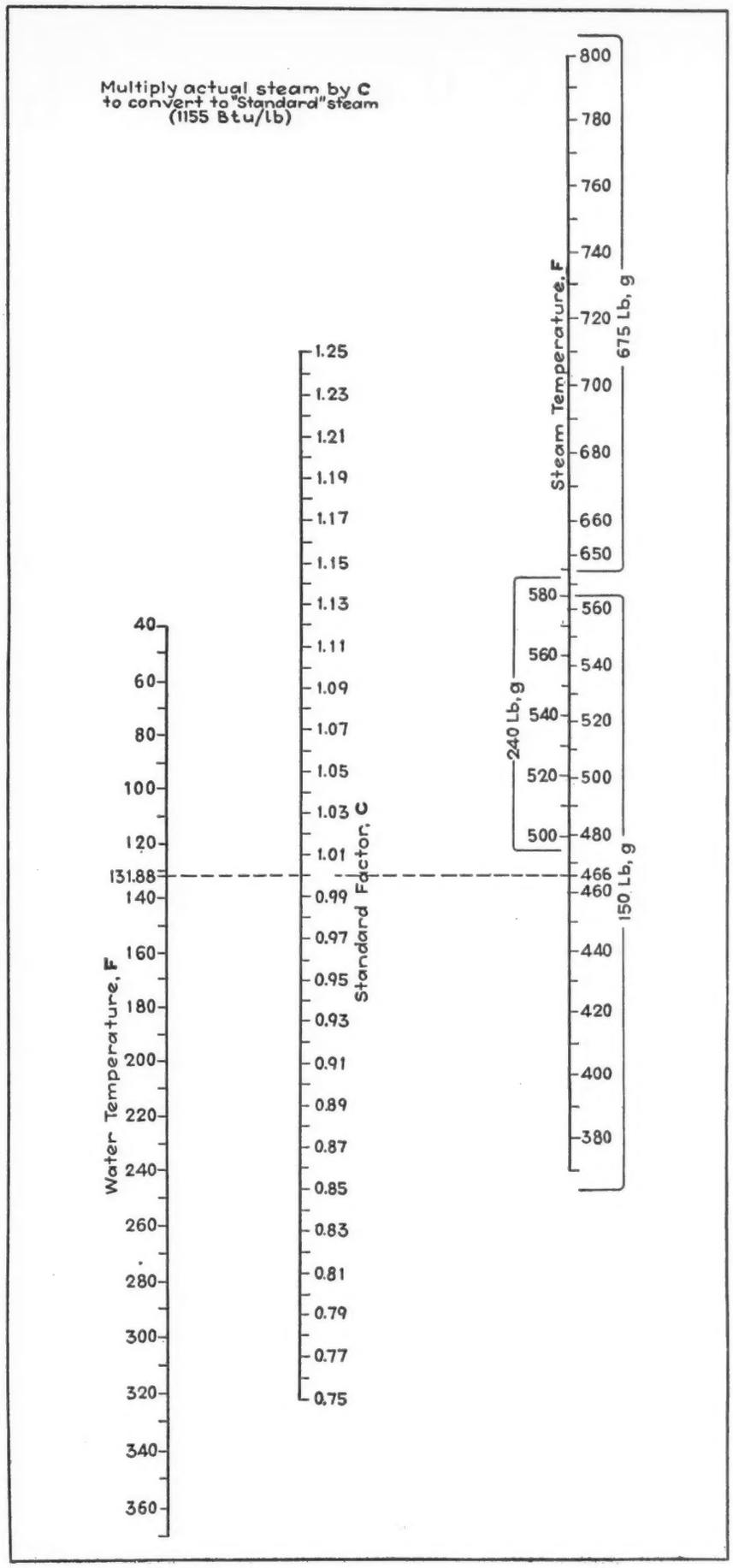

Fig. 2—A correction multiplier, determined from steam conditions and feedwater or condensate temperature, converts actual steam to equivalent "standard" steam

X-Ray Serves Industry

BY C D MORIARTY
General Electric Co, Schenectady, N Y

Whether the job is a 5-in. thick steel casting or 0.01-in. insulating paper, the seeing power of X-rays helps maintain quality of product

DIVERSITY OF WORK in the X-ray laboratory of the General Electric Co at Schenectady requires the utmost in range of power, flexibility of equipment, and continuous development of improved auxiliary equipment. Established in 1930, when a 200,000-v X-ray was the last word in power, this was the first industrial laboratory in this country for X-raying large steel turbine castings. The following year a 300,000-v unit was developed and installed to meet increasing demand for more power to X-ray thicker sections of metal. Since 1936 a 400,000-v unit has been in use in the laboratory.

Heavy metal sections are not the only materials subjected to examination by X-ray. Immediately following the job of X-raying 5-in.-thick sections of a 30-ton steel turbine casting may come one for examining samples of thin insulating paper or cloth. To meet a wide range of requirements, the laboratory has two X-ray rooms. One may be operated as low as 5,000 volts, the other as high as 400,000 volts. Equipment in both rooms may be in operation simultaneously.

Safety

The paramount consideration in the laboratory is for safety. Regardless of how small or great the voltage, operators and bystanders must be protected from the invisible X-rays as well as electrical shock. To meet these safety requirements, walls and ceilings of both X-ray rooms are lined with ¼-in. thick sheet lead, and the doors leading into them, also lead lined, have both automatic and manual safety interlocks.

Close to the ceiling of the large lead-lined room housing the 400,000-v equipment, automatic switches serve to discharge the condensers used in the high-tension circuit. If the door leading into this room is opened while the X-ray tube is in operation, the primary side of the high-tension circuit is broken, and at the same time the gravity-operated switches ground the condenser.

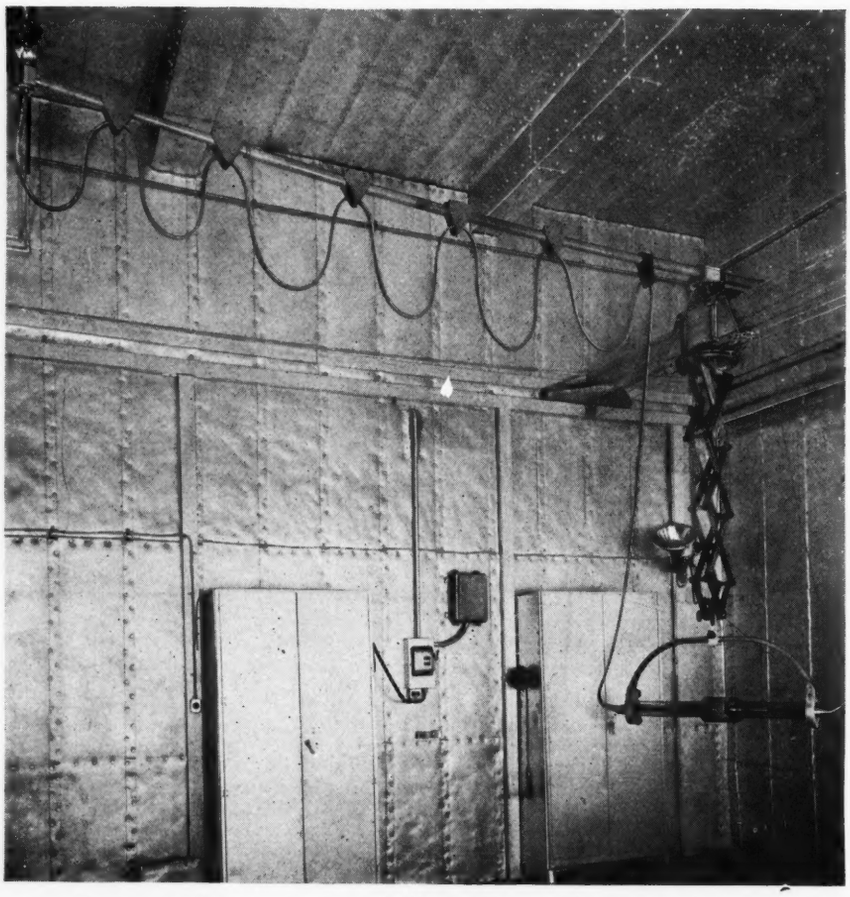

Fig. 1—Flexible mounting for 400,000-volt X-ray tube in lead-lined room

Such elaborate precautions are not necessary with shock-proof and X-ray-proof equipment developed since the G-E laboratory was built, and more commonly used in industry today. In these equipments the X-ray tube and high-tension circuit are contained in a large oil-filled tank. This makes the equipment shock-proof, and in addition, a lead shield completely covering the tube except for one small opening, permits X-rays to be directed at and limited to the work being radiographed.

But certain advantages are obtained in having the X-ray tube out in the open and unencumbered by heavy oil-immersed high-tension equipment in working with objects varying widely in weight, size, and shape. As this method brings the source of the X-ray and the high-tension leads out into the open, the lead-enclosed rooms are necessary.

The larger of the two X-ray rooms of the G-E laboratory is 24 ft square and 18 ft high. The small room is 10 ft square and 9 ft high. A narrow-gage track runs into the larger room from the outside through two sliding doors that provide opening 12-ft high by 10½-ft wide. The trackage runs onto a 40-ton capacity turntable so that objects brought into the room for examination may be readily turned in any direction.

From a position at the control board outside the large X-ray room, the oper-

ator looks inside during operations through a foot-square window of 2-in. thick, 25% lead, plate glass.

To utilize the external X-ray tube to best advantage, a moving tube support was developed that would be extremely flexible, yet strong enough to hold the X-ray tube rigid during exposures. It was mandatory that the support be made of an electrical insulating material, and desirable that it require no floor space. The holder designed to meet these specifications is the "lazy tongs" X-ray tube holder, which has a supporting arrangement made entirely of kiln-dried, paraffin-treated maple. Because the bow holding the X-ray tube may be slid through its single main support and around the curvature, the X-ray tube may be suspended in any position desired.

A ratchet arrangement permits the lazy tongs to be held at any position of extension or contraction, and a carriage rolling on an overhead maple beam supports them through a rotating turntable. This maple beam spans the width of the room and is supported on rollers traveling on tracks fastened to the walls. Movement of both beam and carriage are controlled by ropes from the side walls.

The metal-covered hose forming one side of the high tension circuit, and which also carries oil to the X-ray tube for cooling, is supported on a telescoping textolite tubing. One end of the textolite tube is fastened on a swivel joint, while the other follows the movement of the traveling carriage.

To insure consistent and reliable results when using long exposures on the 400,000-v equipment, the primary is fed through a motor-generator balancing set controlled by a carbon-pile voltage regulator. Voltage fluctuations, caused by heavy current apparatus such as encountered on shop lines where experimental work is carried on, no longer affect radiographic results.

Fig. 2—Control units are in a separate room. Tube operation is observed through lead-glass windows

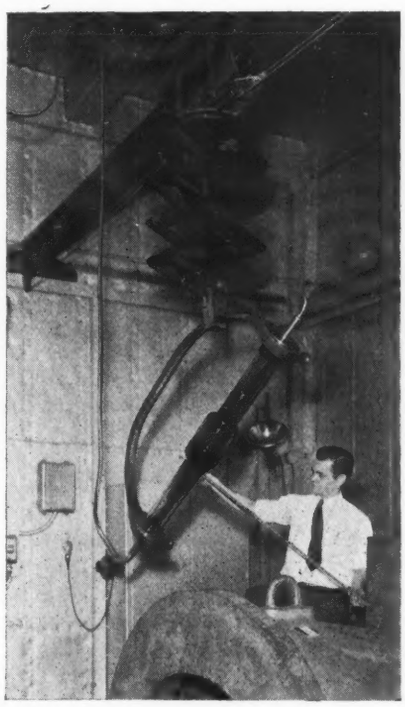

Fig. 3—The author sets the tube in position to X-ray a section of turbine casting

A considerable proportion of the work is of a developmental nature. For example, the customer desires to know how good his product is internally; the foundry engineer wants to know what result his change in technique has accomplished; the turbine engineer wants to know if an improved diaphragm - manufacturing procedure has affected any internal relation; the refrigerator engineer wants to know if internal trouble develops first on a life test; the welding engineer wants to know how his newly developed electrode compares in soundness of weld with other types.

To satisfy these varied demands, the laboratory personnel has devised its own methods of radiography in many instances. One of the biggest problems was to find a way to take perfect X-ray pictures, or radiographs, of irregular steel objects such as chains, round bar stock, pliers, wrenches, etc. To visualize the problem, imagine photographing a man standing in front of a lighted window. The result would be a silhouette of the man against a white background. Now pull down the shade behind the man and you can bring out all of the detail of his clothes. Because X-ray work deals with transmitted invisible light, the problem is not as simple as pulling down the shade.

If a pair of pliers is laid on a film and X-rayed, the unprotected or uncovered portion of the film will be overexposed, resulting in a negative with a white image of the pliers on a black background. The transmitted light of the X-ray makes it necessary that both pliers and film be covered by a material that absorbs some of the X-rays, thereby preventing them from getting to the film and overexposing it. This material has to be of such density or absorbing power that the thin portions of the pliers do not allow the film underneath to become overexposed, nor the thick portions of the pliers leave the film underexposed. In other words, the material must have almost exactly the same absorbing power as the steel of the pliers. Most nearly ideal results are obtained with fine spherical copper shot. Where highest quality radiograph is not necessary, steel shot is used.

Technique

The laboratory has resorted to many so-called "tricks", or devices, aimed at turning out better and more understandable X-ray pictures. A few might be mentioned, such as using a putty to fill in surface defects on steel objects so that they won't confuse internal defects under them on the resulting negative, resorting to plastic lead putty instead of thick lead-sheet forms to blot out unwanted sections, and subdividing the thickness on stereoscopic views into mathematically accurate divisions for ease in locating flaws. Important among the auxiliary devices developed is a new simple stereoscope, and an instrument that accurately records the depth of any internal flaw.

The importance of industrial X-ray should continue to increase as further refinements in equipment and techniques are evolved. As its use becomes more widespread, perhaps a better understanding of the function of X-ray in industry will be brought about. By no means should X-ray equipment be regarded only as a tool to be used in discerning good and bad objects examined. Equally important is its significance as a guide in developing new techniques in processing to eliminate possible defects before they occur, and thus lead to better products.

How to Lubricate With Wick-

By JAMES I CLOWER
Associate Professor of Machine Design
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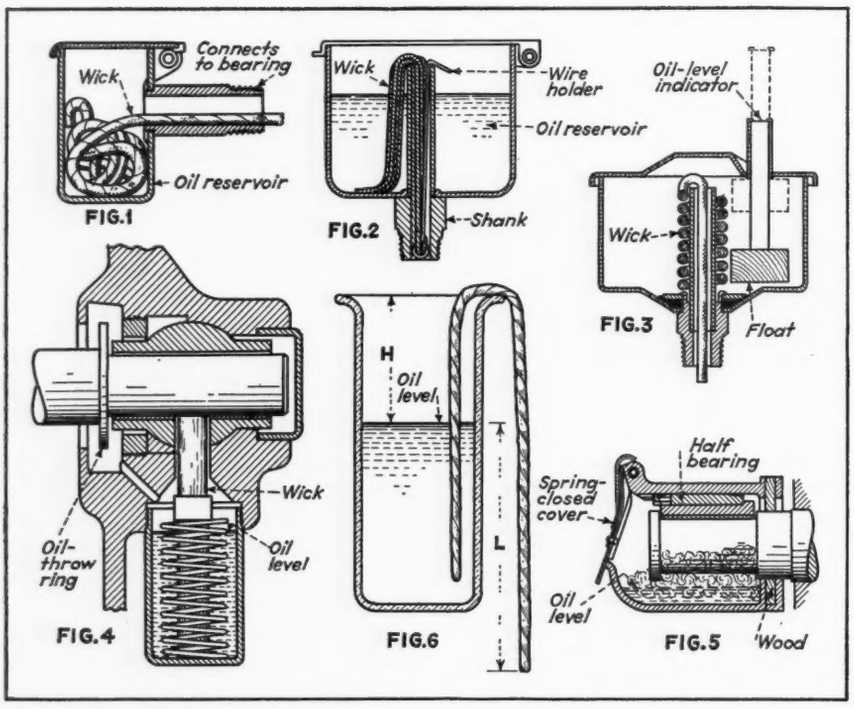


Fig. 1—Side-feed oiler. Fig. 2—Typical wick-feed oiler with single feed and spring-hinged cover. Fig. 3—Wick-feed oiler with float to indicate oil level. Fig. 4—Bottom-feed oiler. Fig. 5—Master Car-Builder, railroad-car bearing lubricated with a bottom-feed oiler. Fig. 6—Wick-feed testing apparatus

WICK-FEED OILING is one of the oldest methods of automatically applying lubricant to bearings, guides, slides and other machine parts. In spite of its antiquity, however, it is still commonly used. Some wick-feed oilers are inefficient and crude, while other more scientifically designed units give excellent results if correctly applied and maintained. Some modern typical wick-feed oilers are shown in Figs. 1 to 5.

For the purpose of discussion, wick-feed oilers may be grouped as siphon oilers, absorbent or pad oilers, and bottom oilers. All are similar in that they employ mainly the principle of capillary action, that is, the absorbent characteristics of a porous material.

If not properly designed, the siphon oiler is deficient in many of the essential features of a good lubricating appliance. This is evident from the results in the table obtained with the simple apparatus Fig. 6, which is essentially a siphon oiler. These data show that when L was less than 0.25 in., no oil flowed from the lower end of the wick, but when L was 0.25 in., pressure was sufficient to break a drop loose every 40 sec. Increasing the length of L increased the rate of feed until the difference between the oil level and the end of the wick became approximately 2 in. Further increasing the length L had but little effect on rate of feed. These results clearly show that in order to have a uniform rate of feed, the discharge end of the wick should be, if possible, about 2 in. below the lowest level of the oil in the reservoir. Many wick-feed oilers on the market do not meet this requirement.

By placing the discharge end of the wick more than 2 in. below oil level, so as to eliminate effect of distance L, effect of varying the length of H was determined. As shown, rate of feed decreased very rapidly as H was increased above 1 in. These results show that the oil level is very important, as the rate of feed varied from 10 to 65 sec. between drops for a change of $1\frac{7}{8}$ in. in oil level in the container.

It is obvious then that wick-feed oilers should be designed wide and shallow to insure a more uniform rate of feed. The tests also clearly indicate the desirability of designing these oilers so that the end of the wick may be placed at least 2 in. lower than the minimum oil level of the reservoir. It is also necessary to have a sufficient number of strands of wicking to supply the required amount of lubricant when the oil is at its lowest level and temperature. These oilers feed an excess of oil practically all of the time and especially so if not correctly designed.

Fig. 2 shows a typical single-feed, siphon oiler. Siphon oilers are the most widely used of all wick-feed lubricators and are made in a variety of forms. In general, however, they consist of an oil reservoir having a central tube which extends well below the reservoir base in the form of a shank. This shank is screwed either into an oil hole in the bearing or into a delivery tube leading to the bearing. A wool or cotton stranded wick leads from the reservoir over the edge of the tube and down inside of it toward the bearing. Oil is raised to the highest point of the wick by capillary action and then flows downward on the discharge side by combined action of gravity and capillary action.

Wick-Feed Receptacle

Many bearings, especially of older design, are built with a wick-feed receptacle cast integral with the top half. In general, these receptacles are too low to permit the discharge end of the wick to be placed as much as 2 in. below the level of the oil in the reservoir. A method of improving such bearings is to place the oil reservoir above the bearing so that the wick can extend down in both.

Effect of oil level on feed rate can be eliminated by so designing the lubricator that oil level remains constant at all times. Two such designs are shown in Figs. 7 and 8. A typical cast-iron, multiple wick-feed oiler of the siphon type, Fig. 9, is widely used in marine practice; consequently, it is frequently called a marine oiler. It is obtainable or can be made with practically any number of delivery tubes, and by dividing the reservoir into compartments, different grades

Feed Oilers

and kinds of oil may be supplied from the same oiler.

The body of the oiler, Fig. 11, which is of the multiple-outlet type, is made of cast aluminum and it is equipped with shut-off valves, individual sight feeds, and individual feed-screw adjustments. When the shut-off lever is in the horizontal position, all valves are closed and no oil feeds. This position of the lever closes the ball checks in each outlet but permits the wicks to feed oil into the secondary wells. Raising the lever to a 45 deg. position opens all valves more than the normal amount, and the oil in the individual secondary wells runs through and flushes the bearings. The lever may be held in this position until all secondary wells are empty or it may be raised quickly and closed again to allow only a small amount of the flushing oil to flow to the bearings. When the shut-off lever is placed in a vertical position, individual wicks feed oil according to the individual screw adjustments. This oiler is obtainable with 3 to 12 feed outlets.

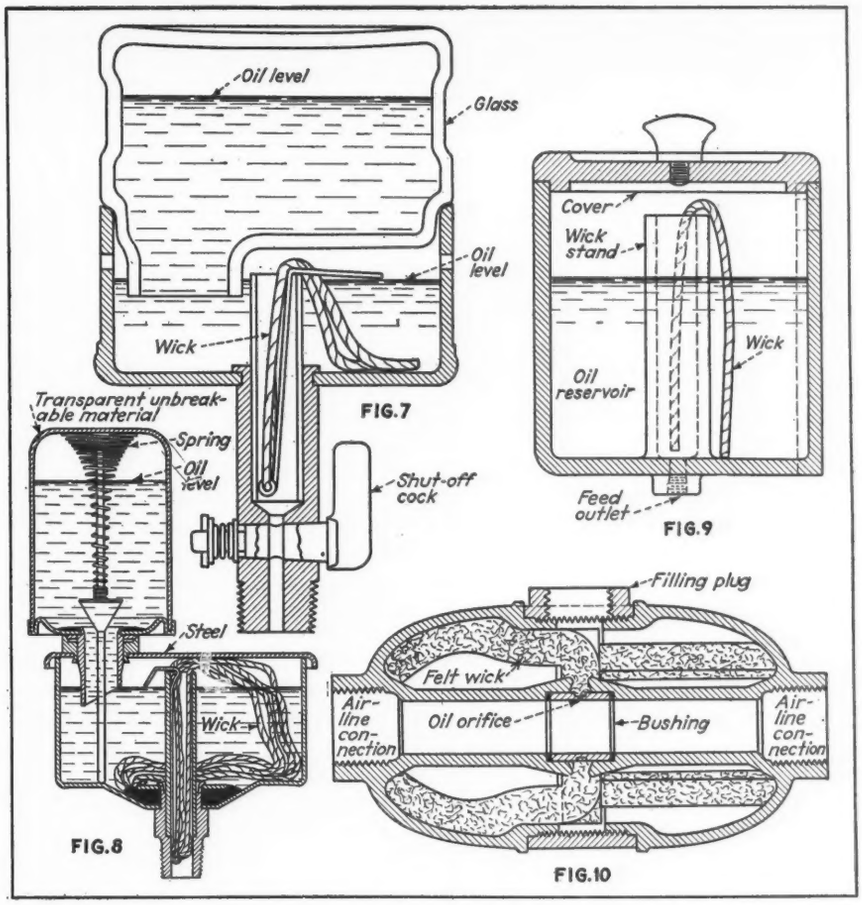


Fig. 7—Oil feed in this oiler is controlled by changing number of wicking strands. Fig. 8—Body of this oiler is made of steel and the reservoir of transparent material. Fig. 9—One section of a multiple wick-feed oiler. Fig. 10—Air-line wick-feed oiler for lubricating air-operated tools

Controlling Feed Rate

A siphon oiler is not automatic as it must be started and stopped by hand. Various devices, such as wire holders, Fig. 2, shut-off cocks, Fig. 7, etc, are employed for this purpose. Feed rate may be controlled by changing the number of strands of wicking; using larger or smaller wicks; varying the amount of twist in the wicking; or by a screw or some other adjustable device that can be clamped against the wick to choke off oil flow. The latter permits closer feed regulation than do any of the other methods. By its use, rate of feed can be reduced, if desired, to less than that of a single strand of wicking.

The simplest and most elementary wick-feed oiler is the pad or absorbent oiler, whose principle of operation is a combination of capillary action and gravity feed. This type of oiler is used for many different purposes, as in Fig. 12 to 14. This method is an improvement over hand oiling but the pad must be renewed frequently or its position changed to maintain a reasonable regular supply of oil to the bearing. Feed rate is at maximum immediately after saturation when the pad is new and rapidly decreases until the pad has drained dry. Designs Figs. 13 and 14 feed oil at all times and have no provision for stopping the flow when the machine is stopped.

Flow is stopped in Fig. 15 by lifting the wicks from the reservoir. This oiler has proved satisfactory for oiling long open-type bearings. Its rate of feed can be regulated by changing the number of wicks, and the felt pad tends to distribute oil uniformly along the journal. This arrangement has been applied frequently to grease lubricated bearings having grease wells in the top half.

Fig. 10 shows a wick-feed oiler designed for air-operated tools. This oiler is placed, for best results in the air line, about 12 ft back of the tool. It will operate in any position and with the flow of air from either left or right. Rate of feed is controlled by using bushings having different size orifices.

Bottom wick-feed oilers Figs. 4 and 5, are quite different from the absorbent pad, generally placed above the journal, and also from the siphon oiler. In this method, the oil reservoir is below the journal, and the oil feeds upward to the journal solely by capillary action through wool or cotton waste or wicking pressed against the lower side of the journal. In some cases, specially treated wood plugs are used as wicks.

The bottom-feed oiler is automatic in that it feeds oil only when the journal is rotating. It is one of the most efficient methods of lubrication, as the excess oil drains to the reservoir and, therefore, is used over and over.

In designing bottom-feed oilers, it should be remembered that capillary action will not lift oil more than 2 or 3 in. The reservoir should therefore be so designed that the oil level will not be more than 2 in. below the point where the wick makes contact with the journal. This oiler is suited for bearings loaded on the top half. It can be used, however, for bearings carrying a light load on the bottom. In such cases, however, it is good practice to extend the wick up along the journal side to avoid area of greatest pressure.

Railway-car axle and motor bearings are generally lubricated by this oiler. A Master Car Builders' bearing is shown in Fig. 5. The oil reservoir

RESULTS OF WICK-FEED OIL TESTS MADE AS IN FIG 6

Height, L inches	*Time between drops, seconds*	*Height, H inches*	*Time between drops, seconds*
4	4.0	0.125	10.0
3	4.0	0.25	11.5
2	4.1	0.5	15.0
1.5	4.5	0.75	19.0
1	7.3	1	24.0
0.57	10.0	1.5	36.0
0.5	17.5	2	65.0
0.25	40.0		
Under 0.25	No flow		

in this bearing is packed with absorbent, elastic waste, which is held in contact with the journal by its own elasticity.

Fig. 4 is a cotton wick-feed oiler applied to a fractional-horsepower motor. The felt wick is held in contact with the journal by the helical spring.

Although waste is sufficiently elastic to hold itself in contact with a journal when properly packed into the bearing, a wick must be held in position by means of a spring of some sort.

Undoubtedly, the best material for wicks and packing is wool, in the form of wool waste, yarn and felt. Cotton materials are superior in lifting and feeding abilities but they glaze or harden readily and have no inherent elasticity; consequently, contact with the journal is easily destroyed by vibration or jarring. Packing waste should be clean and long fibre wool yarn. In general, strands should not be less than 18 in. nor more than 30 in. long.

For siphon oilers, Germantown or Berlin wool yarn is satisfactory for most cases. Spanish wool yarn is satisfactory for conditions that require a small feed and close regulation. One strand of the latter yarn will feed about one-fourth as much as a strand of the former. Wick strands should not be twisted together unless it is desired to reduce rate of feed.

Wire-cored wicking is available and it, of course, retains its form for a longer period of time than other wicking, and is used to some extent in bottom-feed oilers. Stiff wool-felt wicking is generally used for bottom wick-feed oilers, and of correct size and length.

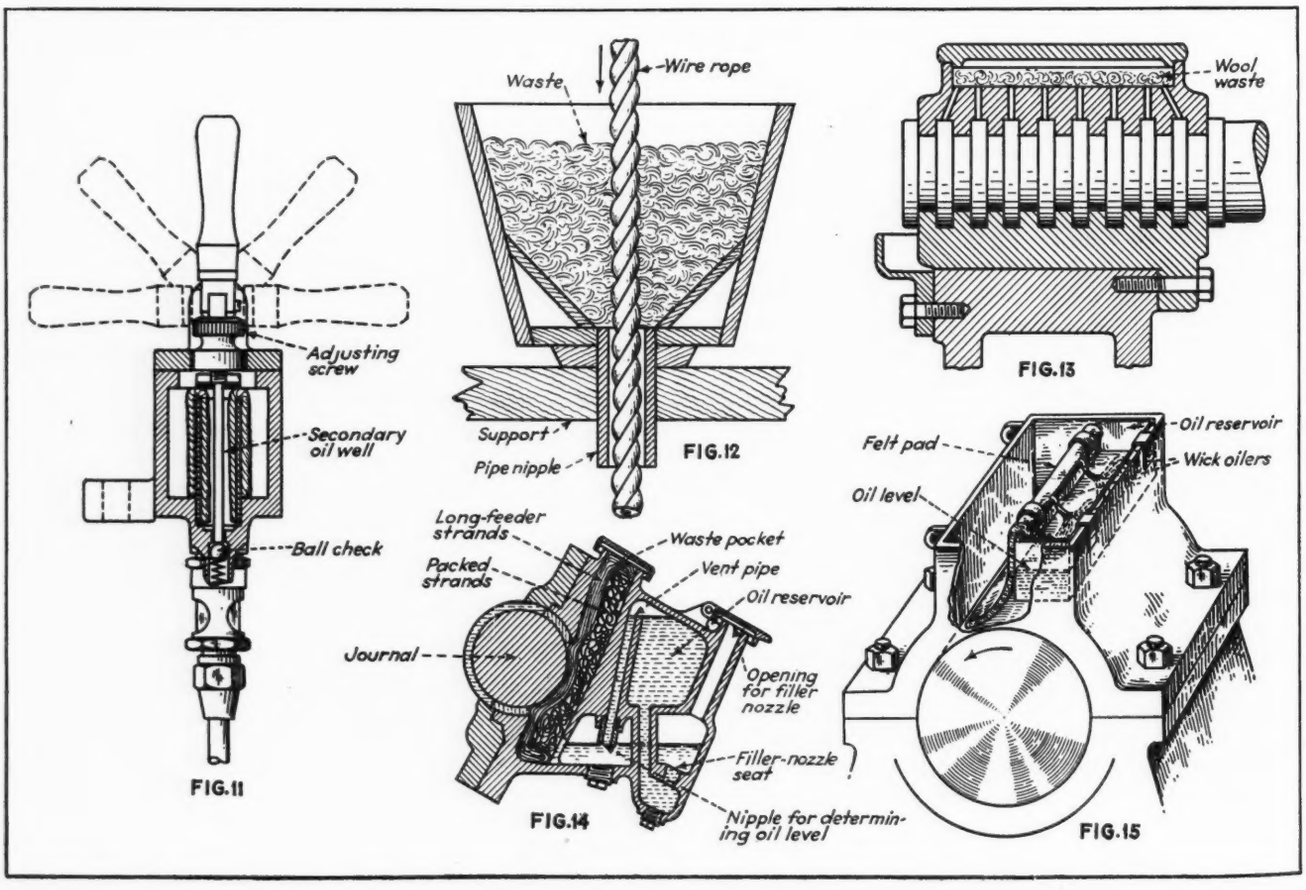
All wicking and packing materials should be replaced or cleaned periodically. Loosen waste packing as the occasion warrants, to bring fresh waste in contact with the journal. This will avoid hardening and glazing conditions which are gradually brought about by contact with a rotating journal. Gasoline or kerosene is suitable for washing and reconditioning wicks, pads, waste, etc.

Generally, a single point of feed is sufficient for bearings not over 8 in. long, and one additional feed for each additional 8 in. or fraction thereof in length. Bearings subject to severe vibration present some difficulty in mounting wick-feed oilers. This difficulty may be overcome by mounting the oiler on a bracket independent of the bearing and connecting it to the bearing by a flexible tube or pipe.

While any sort of an absorbent material acts as a filter and insures that the oil passed to the bearing is relatively clean, it is still important to keep oil clean in handling.

Information for use in the article was supplied by the Gits Bros Mfg Co, Chicago, Ill.; Wm W Nugent & Co, Chicago, Ill.; The Lunkenheimer Co, Cincinnati, Ohio; Dodge Manufacturing Co, Mishawaka, Ind., and Socony-Vacuum Oil Co, New York, N. Y.

Fig. 11—Multiple-feed oiler with shut-off valves and means for flushing bearings. Fig. 12—Wooden box filled with oil-soaked waste lubricates wire rope. Fig. 13—Collar-type thrust bearing lubricated by wool waste saturated with oil. Fig. 14—Constant-level, wick-feed oiler on electric-railway-car motor bearings. Fig. 15—Pad-oiled bearing, in which oil is syphoned from a reservoir by wicks



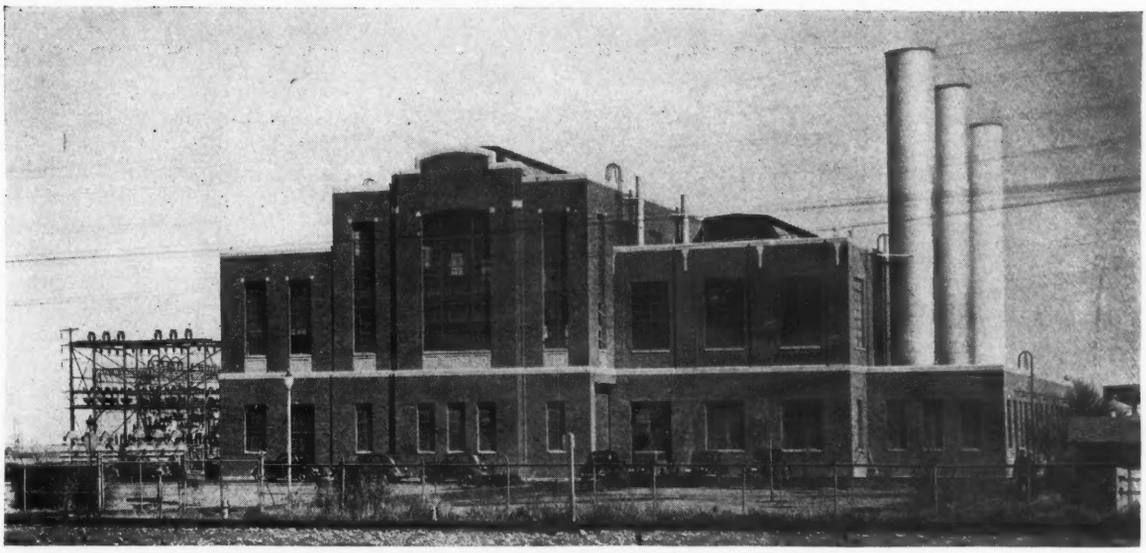


Fig. 1—Makeup water is high in silica at East Plant

An Operator Reports on Feedwater Treatment

Change from sulphate to phosphate treatment at East Plant, Amarillo, Texas, has reduced blowdown, improved scale conditions and decreased maintenance

By E W ROBINSON

Plant Engineer, Southwestern Public Service Co

ORIGINALLY, treatment of boiler makeup at the 22,500-kw Amarillo plant of Southwestern Public Service Co consisted in zeolite softening with no additional treating, but difficulty was encountered in maintaining safe alkalinity without excessive blowdown. The zeolite-treated water, high in soda content, concentrated in the boilers to values of 6000 to 7000 ppm, resulting in severe carryover which rapidly fouled superheater tubes and turbine blading. Scale and corrosion were excessive.

In 1928, a firm of consulting chemists began to supervise the water treating and continued for two years. During this period some modifications were introduced. A sulphate-carbonate ratio of 4/1 was maintained to inhibit caustic embrittlement by introducing sulphates and also by treating the zeolite water with sulphuric acid. Glauber's salt was added when the water analysis indicated need and also when a boiler was filled preparatory to being placed in service. At other times, the sulphate was supplied by the acid treatment, which also reduced alkalinity. A supplementary treatment, adding crude tannin extract, facilitated sludging into the mud drums, and absorbed oxygen in the boiler water. It was also believed that the tannin extract, about 72% tannic acid, inhibited formation of new scale and, to a certain extent, removed old deposits.

Tannin Treatment

The sulphate-acid-tannin treatment was followed for several years until it became apparent that further modifications were necessary. Deposition of scale was not entirely prevented, due mainly to "back sulphation" resulting from the acid treatment. Residual hardness of 1 to 2 grains per gal. remaining after zeolite softening, was converted to calcium and magnesium sulphates by the sulphuric acid, and this back sulphation resulted in the deposition of a thin, hard, sulphate scale on the hotter surfaces of the boiler. In addition, undesirable conditions arose from the use of the tannin extract. Heavy deposits of insoluble tannin compounds, principally iron tannate, built up in feedwater lines and heaters and interfered with operation of valves and feedwater regulators. Serious pitting was also discovered under these deposits.

The tannin-extract trouble was not so serious from the standpoint of efficient operation as was fouling of superheater tubes and turbine blading by heavy carryover of boiler-water solids. Adherence to ASME standard for embrittlement control necessitated carrying high concentrations of sodium salts, principally sodium sulphate. These induced foaming and severe

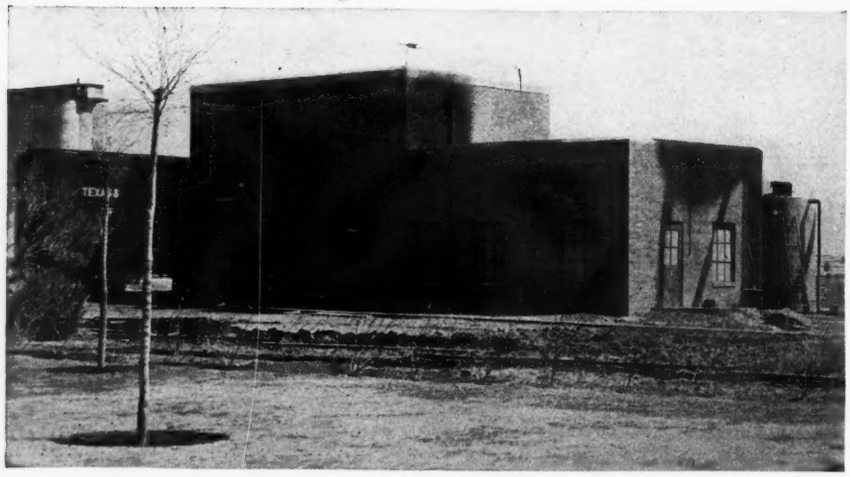


Fig. 2—Softening and treating equipment is housed in a separate building

carryover under certain load conditions. Fouling of superheaters resulted in many tube failures, and low steam temperatures, together with heavy blade deposits, lowered turbine efficiency. Boilers had to be taken out of service for cleaning at intervals of one to two months. During cleaning it was not unusual to remove lumps of solid matter weighing several pounds each from superheater drums.

Changes

To improve water conditions, use of tannin extract was first discontinued, and the acid treatment supplemented with phosphates. The phosphates removed residual hardness of the zeolite water and prevented back sulphation in the acid treatment. This materially decreased scale deposits, but carryover trouble continued. To reduce boiler-water concentration to a value that would eliminate carryover necessitated abandoning the sulphate-carbonate ratio method of inhibiting caustic embrittlement, changing the entire softening plant from zeolite to lime-soda, installing evaporators, or maintaining very high blowoff rates.

Economics favored abandoning the ASME ratio, but we were a little afraid of discontinuing the sulphate control. Assurance, however, was obtained from several consulting chemists that, at least in this particular case, embrittlement could be controlled effectively with phosphates. On chemists' advice and with consent of boiler-insurance underwriters, phosphate treatment was substituted for the acid and Glauber's salt as a supplement to zeolite. The phosphate employed is a special compound purchased from a company specializing in water treating, and is believed to be a mixture of di-sodium phosphate and an alkaline tannate. The compound is intended to remove the residual hardness of the zeolite water, absorb oxygen, precipitate sludge, reduce the formation of silica scale, and inhibit caustic embrittlement. It is necessary to carry only a small concentration of phosphates, usually about 40 ppm, a negligible addition to the total concentration of the boiler water when compared to the 2500 to 3000 ppm of sulphates considered necessary to control embrittlement in the highly alkaline plant water.

A test of a typical sample of boiler water taken from this plant to determine embrittling characteristics was conducted at a university with special equipment for making such determinations. The sample proved non-embrittling after 46 days; failure of the test specimen usually takes place within 24 days if the water is embrittling. Table I of boiler-water analyses indicates the very high silica content of the local water. This high silica concentration led to caustic-embrittlement test, as it is generally believed that silica, in certain concentrations, induces, or at least aggravates, embrittlement in the presence of high caustic concentrations. However, it has been suggested that in this case the silica may actually inhibit embrittlement, and that a reduction in silica content might result in an embrittling water.

The problem of corrosion relative to the boilers is not serious, but corrosion in condensate lines, pumps, and feedwater heaters has been expensive in the past. Destruction of metal in the pumps and feedwater heaters has now been brought under control, but corrosion in the condensate system continues troublesome.

The factors involved in corrosion of pumps and piping are (1) low pH of the condensate and (2) oxygen not entirely removed by deaeration. Condensate pH averages 6.8, slightly acid, causing accelerated corrosion in the presence of dissolved oxygen.

An amine having some of the properties of ammonia is now being marketed as a chemical capable of halting corrosion due to low pH water. It is claimed that this chemical, when introduced into a boiler, vaporizes with the steam and passes through the turbine and condenses with the condensate. Due to its alkaline nature, it raises the pH of the water to a value which inhibits corrosion. Not yet used at Amarillo, this chemical is mentioned as an interesting example of a recent development in corrosion control.

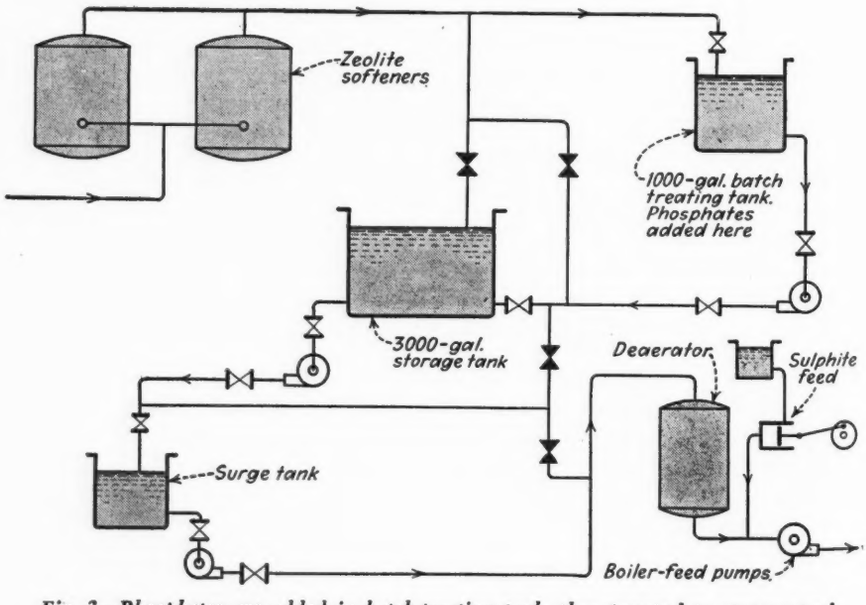


Fig. 3—Phosphates are added in batch-treating tank, then pumped to storage tank or introduced into the system. Sulphite is added just ahead of boiler-feed pumps

Removal of traces of dissolved oxygen in the feedwater after deaeration is accomplished by introducing sodium sulphate at the boiler-feed-pump suction where it absorbs oxygen passing the deaerator, being converted to sodium sulphate in the process. An excess of 30 ppm free sodium sulphite is now maintained in the boilers. The importance of complete oxygen removal cannot be overemphasized. Experience at this plant has proved that oxygen, even in quantities too small to react to the Winkler test, will destroy cast iron parts in boiler-feed pumps, the action being greatly accelerated in the presence of a low pH water.

Silica Increase

While alkalinity of the phosphate-treated water, Table I, is higher, total concentration is much lower than that obtained by acid treatment, the result of abandoning sulphate-carbonate ratio and eliminating crude tannin extract. Increase in silica concentration is believed due to slower rate of scale deposition, which results in an increase in silica remaining in solution. Also the rate of blowoff has been decreased.

The present system of treating is not perfect, as some problems in preventing deposition of silica scale and inhibiting corrosion throughout the condensate system have yet to be solved. Silica deposits still form slowly and limit boiler service periods to about 8 months, which, however, is a great improvement over the service periods of one to two months previously obtained. The raw-water supply contains about 15 ppm silica, but it is believed the greater part of the silica originates in frequent dust storms peculiar to the Plains country. Dust finds its way into the open reservoir and treating tanks and is carried to the boilers. Investigation of beta glucoside as a silica-scale inhibitor and sulpho glucosate as an oxygen-removing agent is now under way and these organic chemicals may find a place in the treating system.

This article is in no way to be construed as a refutation of the ASME Code recommendation in regard to caustic-embrittlement control by sulphates. Departure, such as related here, should be made only under advisement of water-treating specialists, and after water has been checked for embrittling characteristics.

In our particular case at Amarillo, change from sulphates to phosphates has effected large savings through decreased maintenance and increased efficiency, and the record is presented that other plants might profit by similar modifications of their water-treating systems.

TABLE I

Typical analyses of boiler water treated with acid and crude tannin under the previous system, and with phosphates under the present method

	Acid treatment ppm	*Phosphate treatment ppm*
Sodium chloride	187	209
Sodium carbonate	210	100
Sodium hydroxide	420	858
Sodium sulphate	2500	321
Sodium sulphite	0	30
Sodium phosphate	0	40
Calcium carbonate	6	0
Calcium sulphate	15	0
Magnesium sulphate	9	0
R_2O_3	70	10
Organic matter	600	10
Silica	130	269
Total solids	4147	1847
pH	10.8	11.0
Ratio of chloride to tot. alkalinity	0.30	0.22
Ratio of silica to tot. alkalinity	0.21	0.28
ASME Ratio	4.0	0.34

Exhaust Lines

By L N ROWLEY

Things keep happening in air conditioning:—Storage refrigeration (POWER, April, 1938) gains a real foothold with reports of successful large installations in the Middle West and Southwest. That hardy perennial, the reversed-refrigeration cycle, gets another try—this time in the new Westinghouse building at Emeryville, Calif. Announcement of a 425-ton installation in the Soviet Pavilion at New York World's Fair points up the fact that at both Fairs air conditioning will be on parade, both out in front and behind the scenes.

The Japanese are at it again—this time they're running engines on liquid air at —218 F. A small unit is said to have pushed a 27-ft boat along at 4.6 knots, for an hour and a half.

Remember the soot eliminator rigged up by A A Fette at Cincinnati's General Hospital, and described in "No Soot, No Suit" (POWER, March, 1937)? Well, Frank Chambers, head of Chicago's Smoke Inspection bureau, read about it in POWER, liked it, and recommended it. Chicago newspapers carried a story on it, illustrating the device, and later, stories about Mr Fette and his invention appeared in the Cincinnati Post. The whole situation proves that prophets are without honor in their own country, for while the idea seems to have taken hold in the Windy City, the Chicago reports seem to have been news back home in Cincinnati.

Part of the joy of running a telephone company in Peru, where relative humidity nudges 100% most of the time, is sitting watching exchange equipment go to pot. That is, it used to be, until someone requisitioned a room-cooler unit and set it up in a corner of an exchange to see what would happen. Immediate result was heavy condensation in the vicinity of the cooler—long-range result was a dramatic increase in equipment life. It looks like another air-conditioning success story.

Water gushing from the cylinder head of an innocent-looking sewage-sludge-gas engine, from which a spark plug had just been removed, gave operators at the Pueblo, Colo., sewage-treatment plant something of a jolt until one of them remembered that water vapor in the exhaust condensed in the exhaust-gas heater and that the heater was above the engine, with nothing to prevent condensed vapor from flowing back.

Feed such items as trunk curvature, class of bark, taper percentage, length of trunk and diameter at chest height, into a machine devised by a Swedish expert, and you get cubic content of wood in the tree. Obviously, the next step is a machine to grind out income tax returns, complete with notary seals.

Discussion between officials and representatives of British public utilities led to the conclusion that beyond ordinary air-raid precautions every good employer is expected to make, the best procedure will be to set up a national reserve of switchgear, transformers and other electrical equipment. These will be held ready at various centers, for instant dispatch to points damaged by raids.

Sentimental mothers can now keep baby's shoes with no fear of time's ravages, thanks to the ingenuity of Jim Gibbons, metal-spray engineer at American Sugar Refining's Brooklyn plant. When a friend's wife asked him if something couldn't be done about the rotting away of a pair of precious "firsts", he thought of metal spray. It worked and he has since converted some fifty pairs of baby shoes into handsome metal book ends.

What's a Turbine Pump?

It's a centrifugal type, but it can develop several times the pressure of a centrifugal of equal impeller diameter operating at the same speed

By E L ABRAMSON

A TURBINE or regenerative pump is an interesting design and even though it has been in use for over 20 years, it has not received the attention given other designs. In its development it has long since passed the experimental stage.

This pump is a centrifugal type, but is so designed that it can develop several times the pressure obtained from a centrifugal pump having equal impeller diameter and operating at the same speed. Maximum pressure produced by a turbine pump bears no relation to impeller diameter and its speed, but involves capacity and the design of the impeller and the channel in which the impeller blades run.

Power required to drive a given centrifugal pump decreases as the operating head increases, whereas power input to a turbine pump increases with the operating head even though the discharge decreases rapidly. In this respect the turbine pump resembles a positive-displacement design.

Fig. 1 shows a cross-section through the impeller and casing of a centrifugal pump; similar views of a turbine pump are given in Fig. 2. Liquid enters at the center, or eye, of the centrifugal pump; flows in between the impeller vanes and by the action of centrifugal force is thrown outward into the volute channel to the discharge. In the turbine pump, Fig. 2, liquid flows in through passage ways in the center of the impeller and around to the channel inclosing the vanes on each side of the impeller periphery, at a point adjacent to the discharge. Incidentally, there are other designs of turbine pumps that have the suction connecting directly with the periphery of the impeller, the same as the discharge port. After the liquid makes practically a complete revolution in the impeller periphery it is diverted out of the discharge by a partition between suction and discharge openings.

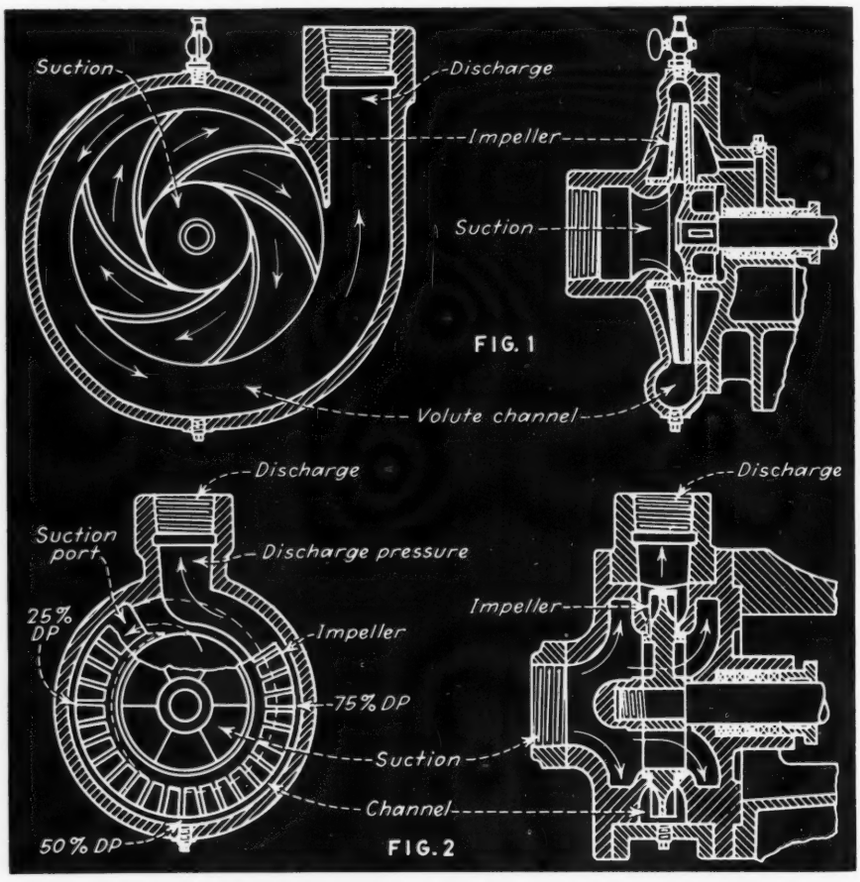


Fig. 1—Cross section of a centrifugal pump with arrows showing liquid flow. Fig. 2—Similar cross section of a turbine pump

Here is a fundamental difference between a centrifugal and a turbine pump. Liquid entering a centrifugal pump can pass between its impeller vanes but once and has energy supplied to it only while traveling the short distance from the inner to the outer periphery of the impeller. In the turbine pump, liquid is recirculated between the vanes. Consequently, energy supplied to the liquid is the result of a number of impacts or impulses given to it by the impeller vanes, while traveling the comparatively long distance from the suction to the discharge nozzle.

These impulses given to the liquid by the blades of the turbine-impeller are comparable to the multi-staging of centrifugal pumps. In multi-stage centrifugal pumps, energy supplied to the liquid is not due to any increase in rotational speed but is a summation of energy received from a number of impellers in series. In just the same way energy supplied to the liquid in a turbine pump is a summation of that received from a number of impeller blades. The number of impulses given to the liquid by the blades of the impeller depends upon discharge pressure and speed of rotation.

Pressure developed in the volute

channel of a centrifugal pump is nearly constant at all points. In contrast to this, pressure developed in the channel of the turbine pump is a variable, being a minimum at the suction opening and gradually increasing to a maximum at the discharge port, as indicated in Fig. 2. This division of pressure is probably not exact for all turbine pumps, but it is approximately as shown.

A comparison of centrifugal- and turbine-pump performance characteristics is given in Fig. 3. These curves are based on actual tests of a turbine pump with an impeller 4.25 in. in diameter and a centrifugal pump with an impeller 6 in. in diameter, the speed for both being 1750 rpm. The figure shows the high head developed by a small diameter turbine-type impeller and the pump's wide operating range. This range is a desirable feature on many applications where the head may vary or where the exact head is difficult to determine.

For instance, the centrifugal pump operates most efficiently at approximately 30 ft total head and 24 gpm, and the turbine pump develops 55 ft total head at this capacity. If the head were increased only 5 or 6 ft, the centrifugal pump would fail to deliver any liquid, whereas the same change in operating head on the turbine pump would simply cause a slight reduction in its capacity with a small increase in power input.

Power requirements for a turbine pump increase as the discharge head increases, reaching a maximum at the shutoff pressure, compared to the centrifugal pump which has its lowest power requirement at shut-off pressure.

Primarily, the turbine pump is a small-capacity and high-head design. For capacities up to 50 gpm it is more efficient than a centrifugal pump and for capacities up to 100 gpm it has a comparable efficiency. Operating head is of course the determining factor, but definite limits of capacity and head cannot be set because of many other variables which must be considered.

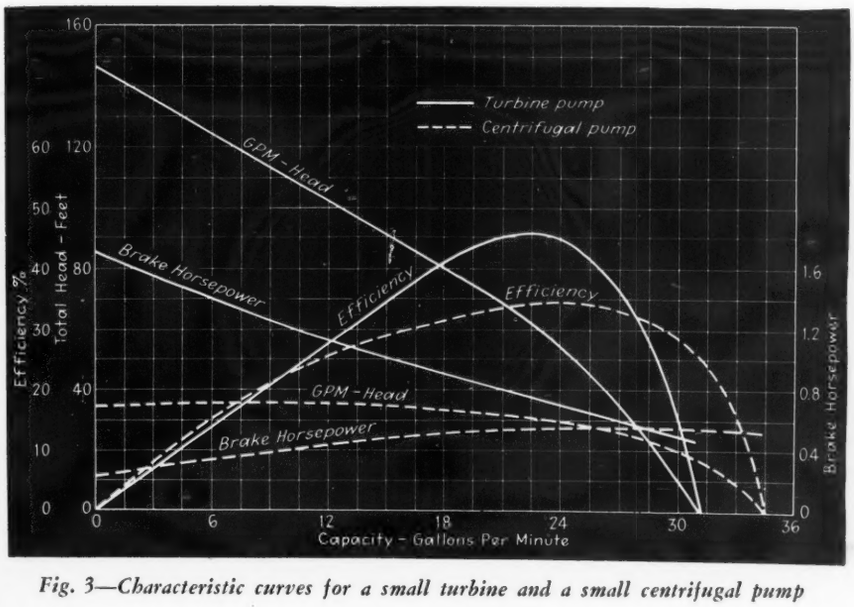


Fig. 3—Characteristic curves for a small turbine and a small centrifugal pump

For High Suctions

For high suctions a turbine pump is ideal, as it has the highest practical lift characteristic of any of the liquid-handling pumps, making it a desirable unit for handling hot and volatile liquids. Turbine pumps are not suited, however, for handling highly viscous liquids or those carrying abrasives in suspension. If a turbine pump is to be used for liquids containing abrasives, then the impeller and sealing surfaces should be made of suitable hard material.

✦ ✦ ✦

Questions for Boiler-Room Engineers

By Harry M Spring

1. Name four firing-door constructions used in vertical tubular boilers.

A—Flanged together and riveted, flanged together and butt welded; both sheets flanged out and riveted (sucker mouth); and the riveted door-frame ring.

2. Name four types of vertical tubular boilers.

A—Straight shell standard, submerged head, Manning, and tapered shell.

3. What are the reasons or advantages for the types other than standard?

A—The submerged head protects the upper ends of the tubes from overheating. The Manning and tapered-shell types allow a large grate area.

4. On what point of construction do you base the maximum allowable pressure in the standard vertical tubular boiler?

A—Strength of the shell or of the furnace in resisting collapse, whichever is the weaker.

5. What other method is used in calculating the maximum allowable pressure of a Manning boiler?

A—Calculate strength of the shell at its point of greatest diameter—between the reverse flange and the top row of staybolts.

6. Is the Economic boiler internally fired?

A—No. Its combustion chamber is steel encased, but the casing is not part of the boiler itself.

7. Name four internally fired boilers.

A—Vertical tubular, locomotive, Scotch marine, and Scotch dryback.

8. What boiler has a crown sheet that is braced similarly to the locomotive crown sheet?

A—The Scotch marine boiler.

9. What internally fired boiler often has more than one furnace, and how many does it have?

A—The Scotch marine or the Scotch dryback frequently has 2 to 4 circular furnaces when the boiler is of large diameter.

10. How are internal furnaces braced?

A—If flat, they are staybolted. If circular, they may be thick enough to be self-supporting for moderate pressures. If they are not thick enough, they can be staybolted, corrugated, or braced by Adamson rings.

11. If used, where should the fusible plug be in any boiler?

A—Not lower than the lowest safe water level.

New Slants on Byproduct Power

Engineers learn how utilities and industrials can save by joint generation of steam and power, methods of burning byproduct and waste fuels, and developments in feedwater research and carryover reduction, at ASME Spring Meeting

Meeting covered and photos by L N Rowley, Asst Editor

INDUSTRIAL PLANTS fortunate enough to arrange with a neighboring public-utility system for joint generation of their steam and power requirements are able to participate in savings resulting from large-scale operations and utilization of byproduct energy. So said August C Klein, Chief Mechanical Engineer, Stone & Webster Corp, and Thomas E Crossan, Supt, Louisiana Station, Gulf States Utilities Co, in a paper "Economics of a Power Plant for Joint Utility and Industrial Service", presented at the Spring Meeting of the ASME, held in New Orleans, Feb 23-25.

First operated in 1930, to furnish steam and power to an adjacent oil refinery and power to the local utility system in Baton Rouge, La., the Louisiana Station is now the largest of its kind. With two chemical plants as additional customers for steam and electric energy, this unique plant generated steam at a rate of 10 billion lb per year, in 1938, with steam sales at a rate of 8 billion lb per year and with generation of byproduct energy at a rate exceeding 300 million kwhrs. Station load factor for the period for both steam and electric operation was 82% and heat in steam sold plus heat in net byproduct power generated was 78% of total heat in the fuel consumed. This compares with approximately 31 or 32% thermal efficiency for a modern high-pressure condensing power plant.

Of major importance in such joint operation is the provision of proper contractual relationships between utility and customers. These were discussed in some detail by the authors, who pointed out the significance of the ratio between steam and power requirements of the large industrial customers. Each contract specifies that the industrial plant will furnish fuel of given kind and quantity: in the case of the oil refinery, half the fuel supplied consists of refinery byproducts. In all cases, the industrials assume responsibility for a part of the fixed charges on that part of the station reserved for their use, through application of demand charges.

Advantages of such a joint operation include reduced capital investment for the industries, concentration of responsibility for power-plant operation in the utility company's hands, freedom from dust, ashes and smoke in industrial properties, shared savings due to dovetailing of steam and power loads, and retention of business ordinarily lost by utility companies not offering steam as well as electrical energy.

Joint Operation on the Coast

A development similar to that at Louisiana Station is taking place on the Pacific Coast where the Pacific Gas and Electric Co is building a steam power plant at each of three large oil refineries. Design features of these three plants were described by C E Steinbeck, Assistant Engineer in charge of Steam Plant Design, in a paper "Power and Steam Plants for Oil Refinery Service." Since plants will be connected to the utility-company system, no difficulty results from unbalance in electric and steam loads. Except for circulating-water supply, foundation conditions and a few minor items, all plants will be the same, producing material reductions in engineering construction and operating costs. In each, three 1525-lb 950-F radiant boilers, fired by natural gas, oil, and acid sludge, will be arranged for outdoor operation, with hot-air ducts between air heaters and burner fronts helping to form an enclosed firing aisle.

Turbine-generator units will consist of a high-pressure machine operating at 240-lb backpressure, coupled to a condensing turbine designed for 240 lb at the throttle, both driving a 50,000-kva hydrogen-cooled generator. The flow diagram shows how steam for process use in the refineries is generated in evaporators, giving a closed boiler circuit.

James M Todd (right), consulting engineer of New Orleans and General Chairman of the Spring Meeting, pauses for a word with A C Klein, Chief Mechanical Engineer, Stone & Webster

In discussion following these papers, A C Klein pointed out a fundamental decision that must be made at the beginning of design of a joint-service station; that is, whether to sell steam as extracted from the turbines or steam generated in evaporators. The first choice means an extensive treatment plant for the high makeup required and may limit selection of high initial pressures. If a double circuit is used, evaporators must be provided and some degradation of energy must be accepted.

Use of semi-outdoor construction saved nearly 10% of the total cost of Mountain Creek Station at Dallas, Texas, according to Harry R Pearson, of the Dallas Power and Light Co. At this plant, the two integral-furnace boilers, of 200,000 lb per hr capacity each, are fired from adjacent sides, with a housing enclosing the firing aisle. The 31,250-kva condensing turbine is enclosed by a steel, brick, and

glass-block structure as small as practicable. A ventilating system supplies filtered air, heated or cooled as required, to all parts of the turbine room, pump room and boiler firing aisle. This feature is expected to be highly beneficial during dust storms and high-temperature conditions.

One incentive to keeping down cost of this plant by use of semi-outdoor construction was the substantial expense involved in providing condensing water. Since there is no stream in the vicinity of Dallas carrying sufficient water for direct condensing and since the ultimate plant will be somewhat large for a spray pond or cooling towers, it was necessary to create a lake with a surface of six square miles at high water line, by building an 8200-ft dam, of rolled-filled earth construction, across Mountain Creek.

Burning refinery byproducts, wood waste, pulp-mill waste, oathulls, bagasse, steel mill byproducts, coal-tar pitch and lignite were described in papers presented at two sessions sponsored by the Fuels Division. A L Wilson, Supt Power Department, at Standard Oil Co's Bayway Refinery, told how sludges, tars and tank cleanings result from refining of various petroleum products and described their general characteristics as fuels. Pointing out the desirability of having burner equipment capable of burning gaseous, liquid, or pulverized solid fuels, either singly, without changing burner parts, or simultaneously, Mr Wilson described several typical refinery installations and burner-equipment. Discussion brought out the need for keeping gas temperatures above the dewpoint to save heating surfaces from action of corrosive fuels such as acid sludge.

Burning Waste Wood

Illustrating the general character of waste wood by several typical analyses, Henry Kreisinger, Combustion Engineering Co, showed how the high moisture and volatile content, and low fixed carbon of this fuel, dictate a 3-stage combustion process involving evaporation of moisture, distillation of volatiles and burning of carbon. The greatest part of the combustion occurs above the fuel bed and this indicates that as much as 90% of air should be supplied over the fire with only 10% coming through grates.

Describing the mechanism of burning of individual pieces in some detail, Mr Kreisinger showed how rate of combustion depends on the rate that heat is supplied for evaporation of moisture and distillation of volatiles, and size of fuel particles. Since moisture in the fuel is the greatest factor affecting temperature of combustion, the author analyzed its effect in detail.

T E Crossan (left) and C E Steinbeck talk of joint industrial-utility plants—Crossan runs Louisiana Station, Steinbeck designed Avon, Martinez, and Oleum

Discussion of the drying process and dryers, of the effect of moisture on efficiency and the distribution of air in the furnace brought the paper to a close. In a written discussion, A A Smith, Canadian International Paper Co, stated that for operation at high ratings, 75% of air should come through grates rather than 10%. In further discussion on under-grate vs overfire air, the need for air flow to keep grates cool was indicated.

A ton of dissolved organic matter is carried in the waste liquor resulting from the making of one ton of pulp by the acid-sulphite process; this represents a problem in disposal and an opportunity for useful recovery. A method of treating these liquors by fractional precipitation was described by Grover Keeth, Marathon Paper Mills Co. One product of the treatment is a lignin fuel product running about 68-70% moisture and having about 8000-8500 Btu per lb on a dry basis.

Principal problem in utilizing this fuel was reduction of moisture to about 50%, which was finally effected in a specially designed filter press. Numerous methods of burning were tried either alone or in combination, and with the installation of spreader stokers, it was found that as long as the fuel was about 50% solids, a mixture of 85% lignin and 15% coal could be burned in continuous operation at 100-150% rating. Mr Keeth presented considerable data on various methods of drying and burning the fuel and gave some boiler test results.

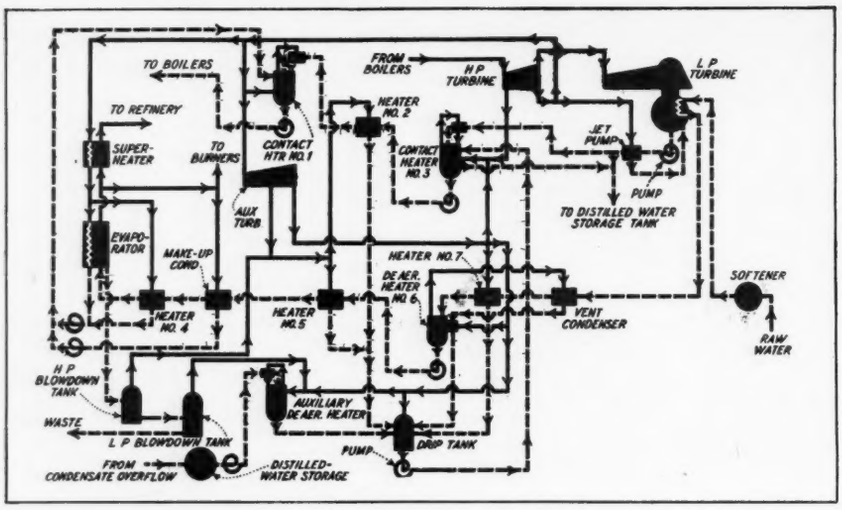
"Burning of Oathulls", a paper by C J Herbeck, Chief Engineer, Iowa Electric Light & Power Co, told of attempts to burn surplus hulls supplied by the Quaker Oats Co. Use of underfeed and chain-grate stokers proved unsatisfactory as did burning in powdered-fuel boilers until grinding the hulls was undertaken to increase capacity and reduce trouble from ash and partially burned hulls being carried out of the stack.

In a properly designed modern sugar factory, heat from bagasse-burning will generate all steam needed, according to E W Kerr, consulting engineer of Baton Rouge, La. Bagasse, the woody matter remaining after sugar juice has been removed from sugar cane, is composed of fiber and moisture in nearly equal amounts, with small amounts of sugar and other solids. Because of its high moisture content, large furnaces are needed and efficiencies are bound to be low. Numerous types of furnaces developed during the long history of bagasse burning were shown by Mr Kerr, and test efficiencies and capacities of several units were also presented.

Byproduct Fuels

Principal byproduct fuels of the steel industry are blast-furnace gas, coke-oven gas, coke breeze, and tar, and the characteristics of each and method of determining their most economical use were discussed in a paper by Gordon Fox and W B Clemmitt, Freyn Engineering Co. Blast-furnace gas is bulky, dirty, not well suited for storage or extensive distribution, while coke-oven gas, the other major steel-mill fuel, is clean, has high heat content and develops a high flame temperature. The latter gas can sometimes be sold for use outside the mill. Each heating operation in the mill has its special requirements, so that a real problem in engineering analysis is presented in matching fuel quantities and qualities to load requirements. Usual practice is to allocate furnace and heating requirements as carefully as possible and to use surplus fuels in the power-plant boilers with a base fuel such as coal or oil to make up for deficiencies.

Coal-tar pitch is a residual of the distillation of oils from coal tar and varies from a soft, semi-fluid to a brittle, grindable solid. Production of the hard grades exceeds demand for industrial use and the many efforts to burn it as a fuel were told by E W Clarke, Chief Engineer, Koppers Co, who described a method of burning this fuel successfully in pulverized form. To overcome plugging of the burner with pitch softened by furnace heat, the



Flow diagram, plants built by Pacific Gas & Electric Co for oil refineries

burner is located entirely outside the furnace, and fuel is fired in such a way as to avoid contact with heated surfaces before burning in suspension. Since fuel pitch is nearly all volatile matter and fixed carbon, with only traces of ash and sulphur, it is particularly suited for use in industrial furnaces.

The Southwest, rich in easily transportable high-grade fuels such as oil and gas, has a solid fuel reserve of low-grade lignite, use of which is probably confined to proximity of the mines. Lignite, efficiently fired, may be economically superior to oil and gas in many parts of the Southwest, and it was to accumulate data to guide potential users of the fuel that the University of Texas started the investigation described by Prof Carl J Eckhardt in "Lignite—a Grate-Fired Fuel of the Future in the Southwest."

Water losses from lignite with moisture up to 35% are not nearly as great as thought to be, the actual loss running about 10.5% of the fuel's potential heating value (this figure includes evaporation of moisture, moisture from burning of hydrogen, and loss from moisture in air). Best results in burning lignite were had with a traveling grate stoker in a setting designed to overcome usual troubles with lignite. Important factors in improved performance with this unit were provision of undisturbed fuel bed for an essentially free-burning fuel, and substitution of a long low-hanging rear arch for the usual front arch. Passage of hot gases from rear of furnace to front, in a direction opposite to motion of the fuel bed, reduced ashpit losses and promoted mixing of rich and lean gases.

Five years experience shows that lignite-burning systems can be operated with high availability and with efficiencies in the neighborhood of 75% at maximum capacity. Maintenance on stoker and refractories has been low. Amount of solid material passing through grates amounts to about 0.1% of fuel burned, and part of this material burns below the grate, so siftings losses are negligible.

In discussion following this paper, Messrs Di Lorenzi, Kreisinger, and Van Brunt, of Combustion Engineering Co, brought out the following points: heat releases of 22,000 to 30,000 Btu per cu ft per hr may be obtained in furnaces burning pulverized lignite and burning rates of 55-60 lb per sq ft per hr are possible on stokers; high-resistance grates, overhanging rear arch, and narrow furnace throat are important features of any grate-fired lignite installation; although most combustion takes place over fuel bed, bulk of air must pass through grates to keep metal temperature down, and small quantity of overfire air must have high velocity to promote turbulence and mixing.

Tube Failures

Recently, a number of new 1200-1400 lb boilers have lost tubes inclined at only a small angle to the horizontal. These failures, according to a paper "Attack on Steel in High-Pressure Boilers as a Result of Over-heating Due to Steam Blanketing" by E P Partridge and R E Hall, Hall Laboratories, Inc, have occurred in most cases under conditions precluding scale formation or oxygen corrosion and have been characterized by wasting away internally along the tube top, finally cracking without excessive deformation. The authors believe formation of a blanket of steam along the top of such tubes is responsible, its insulating action serving to greatly increase metal temperature and when water is thrown intermittently against the excessively hot ceiling of the tube, local concentration of boiler water is possible. High sodium hydroxide concentrations destroy the protective oxide coating in the tube, and rapidly attack the steel.

Results of experiments reported by F G Straub and E E Nelson, University of Illinois, in "Corrosion in Partially Dry Steam Generating Tubes" indicate that water chemicals concentrate at the dry portion of the tube, and that corrosion in the dry area is undoubtedly produced by action of the sodium hydroxide in the boiler water concentrating on the dry areas. If metal temperature is below 750 F, sodium hydroxide appears to be the active constituent in the boiler water causing the corrosion, and the corrosion may be controlled by reducing free causticity to zero and adding other salts such as sulphate, silicate, etc. If metal temperature is above 750 F, corrosion takes place in the absence of sodium hydroxide, and chemical treatments effective at the lower temperature are no longer protective.

Baffle Arrangement

Reporting on tests to determine a baffle arrangement for steam drums that would prevent objectionable carryover during normal operation, M D Baker, Chief Chemist, Springdale Station, West Penn Power Co, described in some detail arrangements for testing steam purity by the conductivity method and the various precautions necessary for accurate results. Riser-extension baffles failed to solve the problem and impact-box baffles, although better, were subject to a critical water level.

In the third and final baffle design, steam and circulating water delivered by each riser or group of risers discharges into individual cyclones, located in the drum, which separate water and steam before release into the main portion of the drum. Cyclones are placed vertically and so located that openings at the bottom are normally below water level and top openings are well above the usual water level. These cyclones delivered steam having a conductivity of only 1.5 micromhos until water level in the gage glass was raised above top of cyclones. No appreciable effect on amount of carryover was noted over a range of water concentrations up to 1573 ppm.

CORRECTION

In "Europe Turns to Gas Producers", February, 1939 POWER, page 91, the opening labeled "Gas inlet" in the down-flow producer, Fig. 2, should have been marked "Air inlet".

Readers' Problems

Questions for Our Readers

Does Reduced Pressure Save on Heating System?

Question 1

OUR JOB *is to heat a 22-story building with a vacuum system. Boiler pressure is 100 lb, which is reduced to 40 lb at the main header, and further reduced to 2 lb between 3rd and 4th and 16th and 17th floors, feeding up and down from each place. Vacuum carried on the return side is 5 lb. Experiments seem to indicate that reducing pressure at the main header to 10 lb, by use of manually operated gate valves, results in lower coal consumption. Assuming the system is absolutely tight and perfect, which condition should be most economical? Why? Also, is there any recognized method by which the proper vacuum to carry can be determined?*—HAD

Oil in Boiler Water

Question 2

WE HAVE *two 3500-sq-ft Stirling boilers, one 550-hp and one 200-hp engine, a steam-driven air compressor, and the usual auxiliaries. Engines exhaust to a 12-in. line supplying the building-heating system and connected for atmospheric exhaust when not heating or when backpressure exceeds 5 lb. The 12-in. line has two oil separators, one at each end of the engine room. Drainers are also provided, and are inspected daily to insure proper operation. The open exhaust heater is also equipped with an oil trap which is working properly.*

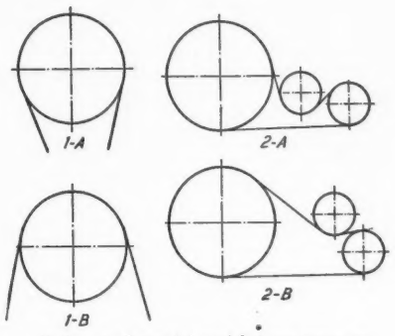
Every winter we are troubled with oil in the water supply which is carried to the boilers. The insurance inspector says we should have an oil extractor in the water lines, as the separators and drainers will not eliminate all oil from the exhaust steam. Engineers claim that if the separators and drainers are working properly, they will eliminate all oil. We have all lubricators cut down as low as possible, and we inspect engine valves monthly, for lubrication and wear. Should the separators and drainers take care of all the oil, and what might be the reason for oil getting into the water supply? What is the remedy?—MEF

Belt Flexing

Answers to February Question 1

The Question

RECENTLY *I got into a discussion regarding the flexing of a belt running over pulleys. To put it in a nutshell, will the belt in 1-A flex more than that in 1-B, and will the belt in 2-A flex more than that in 2-B. The question only concerns flexing, with no consideration given to adhesion or hp delivered*—FG



Pulleys in Cases 1-A and 2-A are same as in Cases 1-B and 2-B, respectively

[Apparently Questions published in February covered ground familiar to power engineers, because a record-breaking number of replies were received; 13 to Question 1 on Belt Flexing, and 28 to Question 2 on Feed-Pump Trouble. Space limitations made it impossible to print any substantial percentage of the replies, many of which were naturally similar. To give proper representation to all who took time and trouble to submit answers, it was necessary to depart from the usual way of publishing answers.—ED]

"A" Belts Flex More Than "B"

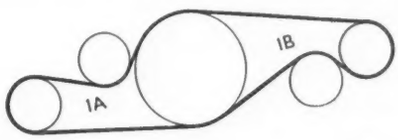
HARRY BENTON, *Hartford, Conn.* "The word flex means to bend or change from a straight line, and from that viewpoint it would seem absolutely certain that the belts in 1-A and 2-A flex more than those in 1-B and 2-B. Certainly, after a belt has been wrapped around the pulley for approximately 200 deg of its circumference, it has been flexed more than when it is wrapped around the same pulley for 180 deg, and the same holds true if, as in case 2, the belt is wrapped around for 270 deg, which means more flexing than when wrapped around only 190 deg.

J P SIMONS, *Lakewood, Ohio,* points out that few handbooks say much about flexing, confining themselves to flexibility of belts produced by various methods of curing the leather. He agrees with Benton that the belts in "A" flex more than those in "B", and for much the same reason. He adds that most manufacturers consider double flexing harder on a belt than when curvature is all in one direction. However, if only a definite length of the belt is considered, the answer would be different; the curvature of a definite length depends on the pulley size. But that is not the real measure of belt flexing. The belt must make the complete circuit and the bending or flexing must be measured around the circuit.

J C REYNOLDS, *McKeesport, Pa.,* casts another vote for more flexing in the "A" belts, citing the greater angle of contact as the reason. R L BROWN, *Sloat, Calif.,* tells the same story, as does F W NEUBRANDER, *Cleveland, Ohio.* Smaller curvature of the other pulley in 1-A (not shown) would cause more flexing, assuming equal belt speed, load and tension, according to LESLIE BRADLEY, *Bismarck, N. D.* With diameters of all pulleys in case 2 the same, position of the idler in 2-A causes more flexing. Assuming exactly equal conditions for all belts (speed, load, tension, and care given them), life of the belts in 1-A and 1-B would be practically alike. There would be a much greater difference in case 2, and life of belt 2-A would be shorter and maintenance greater. If all belts shown were laced instead of endless, the flexing of 2-A would cause much greater wear to lacing and especially to the holes punched in the leather.

E H CARLSON, *Fresno, Calif.,* also believes that the "A" belts will flex more than those in "B", and points out that the "A" belts have more surface contact and are obviously capable of transmitting more power without slippage. When considering flexing of a belt, it should be recognized that power is consumed in bending the belt around a pulley and straightening it out and, for this reason, pliability of a belt is a most important factor in securing satisfactory performance. A stiff belt not only increases power consumption but provides poor gripping surface, inducing slippage, produces cracks in belting, and is usually short-lived.

ALLAN WOKES, *Manitoba, Canada,* refers to experience for his answer, presenting the accompanying sketch of belting for a Corliss with double-band wheel, 16



ft in dia by 3 ft face. Using double-ply leather belts, this engine has been run about 5 months, double shift, every year for the past 27 years. Load is fairly even on both belts. Belt 1-A was replaced 5 years ago; Belt 1-B is still good for several seasons, although showing signs of age.

The Other Side of the Case

GEORGE BLUM, *Marissa, Ill.,* states his case thus: a belt running over a pulley flexes twice, once where it begins to curve around the pulley and once where it straightens out. This may be regarded as one complete cycle, for as the belt leaves the pulley its fibres merely return to normal from their states of tension and compression. The bend or flex remains in the belt until the semicircuit

about the pulley is completed and the belt cannot be considered to flex from point to point of progress. Amount of flexing depends inversely on the pulley diameter and on little else, least of all the length of the belt touching the pulley. The usual belt running from a small driving pulley to a larger one will, if there is no idler, flex just four times per circuit. Flexing on the driving pulley will be greater if it is smaller in diameter.

If an outside idler is used as shown in FG's sketches, over-all flexing of the belt will be doubled, for in running under the idler the belt flexes in the opposite direction. If idler is smaller than driver, flexing will be more than doubled. To prevent extreme reverse flexing with greater belt stretching and shorter life, the idler should be as large as possible. Running idler inside the belt insures longer life but increases slippage and decreases horsepower. Since, in thicker belts, outer fibres must stretch more and inner fibres be compressed more, 2 or 3-ply belts should not be run over very small pulleys or idlers.

J C PORTER, *Saltville, Va.*, agrees that flexing depends on radius of pulley, but points out that due to the longer arc of contact on pulley 1-A, internal stress will be greater and belt life less than on pulley 1-B. Also, in 2-B, high position of the idler means more tension than in 2-A. The low idler in 2-A, although it has a greater arc of contact than 2-B, will cause less wear on the belt because the reverse bend neutralizes displacement in the fibres of the belt caused by the small pulley. There is no difference in flexure in the two cases, but 2-A will make a more durable, trouble-free drive.

A J LUBELY, *Old Bridge, N. J.*, analyzes the situation in much the same manner as George Blum, but calls attention to the frequency of flexing which depends on belt speed and over-all length of the belt. Assuming FG's belt speeds, belt lengths, and pulley diameters to be the same in the various cases, then the "A" belts will flex exactly the same amount as the respective "B" belts. In either case increasing belt speed would increase amount of flexing, while lengthening the belt would decrease it, if pulley diameters remained unchanged.

It is interesting to note that the flexing effect in case 1-A would be more severe than in 1-B if complete drives are considered, due to the fact that 1-A has a smaller pulley at the other end than 1-B, thus causing greater bending of the belt fibre.

C S STOUFFER, *Pottstown, Pa.*, also notes that the pulley not shown in 1-A must be smaller than the similar pulley in 1-B, saying "both belts will flex or bend the same so far as concerns the pulleys actually shown, but the other pulley of each pair affects the amount of bending, and consequently the life of the belt". He also agrees that flexing will be the same in 2-A as 2-B, summing up the whole story as follows: "In both cases, the question can be answered readily if we remember that flexing of a belt on a pulley depends on the diameter of the pulley and is not affected by the proportion of the pulley covered by the belt".

J J WYNHOFF, *Racine, Wis.*, points out that once the belt takes on the arc of the pulley, it keeps the same curvature until leaving the pulley. He concludes that it bends only once for each time that the belt travels around the pulley, and regardless of the length of time that it remains on the pulley, the flexing is only twice (once going on and once going off) for each revolution of the belt.

Feed-Pump Trouble

Answers to February Question 2

The Question

WE USE *a duplex pump to return condensate to boilers from a small reservoir to which traps return hot water. The reservoir is about 4 ft from the pump, and water level stays 5 or 6 ft below pump suction. Though repaired only a year ago, the pump now runs jerkily, even when the water-piston packing is changed. What is the matter?—CAC*

Blame Suction Lift

Nearly all answers to CAC's question point a finger at the 5-ft suction lift with hot water. W T ESTLICK, *Ansonia, Conn.*, starts the ball rolling by pointing out that suction lifts up to 25-28 ft are obtainable with cold water, but that as the temperature of the water goes up the possible lift is decreased. Theoretically, water at 200 F can be lifted 6 ft but in practice, water above 135-140 F will often cause erratic pump operation on suction lifts of 4 or 5 ft. Decreasing the suction lift might help, but best bet would be to raise tank level to give a positive suction head.

ERIC ERNST, *Staten Island, N. Y.*, states that a displacement pump such as CAC's depends on partial vacuum within the plunger cylinder to pull water into the pump and becomes steam bound when the suction lift is too great for the water temperature. Vacuum is destroyed and steam is alternately compressed and expanded within the plunger cylinder, with boiler pressure holding the discharge valves down. Lowering water temperature would be one solution, but raising suction head to 5 ft will handle water up to 190 F safely. CAC's trouble could also be caused by leaky check valves on boiler feed lines during periods when pump is running slow and if suction and discharge valves on the pump are in poor condition.

TIMEO DANAOS, *Passaic, N. J.*, points out that CAC is saving fuel by getting higher temperature returns than expected. To solve the suction-lift problem, he suggests carrying a higher water level in the receiver, lowering the pump foundations, or lowering receiver temperature. Lowering pump should be best and should be adopted even if it means digging a pit for the pump.

EARL PAGETT, *Coffeyville, Kan.*, describes the effect of partial vacuum on hot water, causing vaporization which interferes with pump operation. Before CAC makes any changes he can find out whether steam binding is the cause of the trouble by adding cold water to the condensate, bringing it down to about 160 F, and then watching the operation of the pump. If the pump behaves as it should with cooler water, then it will pay to spend some money to lower the pump or raise the receiver.

Vaporization

S H COLEMAN, *Roanoke, Va.*, puts down as most likely cause of trouble vaporization due to high temperature at the submerged end or moderate temperatures at this point and high friction losses in the line. With water above 150 F, it is practically impossible to raise it 5 ft without flashing and vapor binding even though piping is adequate. If pump can't be lowered or tank raised, a lift fitting installed in the suction piping similar to those used to raise condensate from depressions below normal grade in vacuum-heating-system return lines, will help overcome the trouble. If jerky operation is recent, leaking traps may have caused the rise in water temperature. As other possible causes, Coleman lists leaks in suction piping, obstructions in suction piping, pump-suction valves in poor shape, and packing not suited to hot water.

F F NICKEL, *Irvington, N. J.*, also believes the suction lift is too high for the water temperature, and refers CAC to his book "Direct Acting Steam Pumps", page 21, where he will find a diagram giving attainable suction lifts for water at various temperatures. At 150 F, only 2 ft lift is possible, measured from water level to center of pump, while for a lift of 7 ft, temperature should not exceed 125 F.

A R CIOTTI, *Cleveland, Ohio*, figures that if the pump is in good mechanical condition, condensate temperature must be causing the trouble and gives a short table of suction heads recommended for given conditions by a manufacturer of duplex feed pumps:

Altitude above sea level, ft	Condensate temperature, F	Suction head required
2000	150	1 ft
2000	160	3
2000	170	5
2000	180	7
2000	190	10
4000	150	3
4000	160	5
4000	170	7
4000	180	9
4000	190	12
Sea Level	170	3
Sea Level	180	5
Sea Level	190	7

From the table it can be seen that CAC's pump will not run free of trouble until it is given the proper suction head to meet the local conditions of water temperature and altitude. That he mentions the receiver as "small" leads to the conclusion that there is little storage capacity and radiation surface, giving the condensate little chance, if any, to cool

(*Continued on page 140*)

Power Lines

Scott Paper Co Completes Addition

The $2,500,000 expansion program of the Scott Paper Co begun last July is rapidly nearing completion.

Last month, steam-generating facilities of the Chester, Pa., plant were increased from 250,000 to 320,000 lb per hour by completing installation of a Combustion Engineering Type VU steam generator of 125,000 lb capacity, operating at 635 lb pressure and 750 F, and two Foster Wheeler evaporators of 30,000 lb output per hour to insure a continuous supply of condensate for boiler feed.

A General Electric, double-extraction, 5000-kw turbine-generator completes new major power equipment.

Midwest Power Conference In Chicago, April 5-7

The second annual Midwest Power Conference will be held April 5–7 at the Palmer House, Chicago, Ill. The conference is being sponsored by Armour Institute of Technology with the cooperation of seven other midwestern colleges and universities, and local engineering societies.

Preliminary program released last month included the following papers: "Problems of the Small Industrial Power Plant", by F Elwell, Works Engineer, Buick Motor Div; "Small Utility, Municipal and University Power Plants", by G A Gaffert, Mechanical Engineer, Sargent & Lundy; "High-Temperature, High-Pressure Metallurgy", by J C Hodge, Chief Metallurgist, Babcock & Wilcox Co, Barberton, Ohio.

"The Influence of Creep Studies upon Allowable Design Stresses", by J J Kanter, Research Metallurgists, Crane Co; "Social Significance of the Development of Diesel Power", By L H Morrison, Editor, *Diesel Power;* "Reducing Pollution of Air by Power Plants", R V Kleinschmidt, A D Little Co; "Power Plant Auxiliaries", by G C Daniels, Mechanical Engineer, The Commonwealth & Southern Corp; "Power Plant Statistics", Arthur L Rice, Editorial Director, Power Plant Engineering; "American Pump and Turbine Development", by R V Terry, Hydraulic Engineer, Newport News Shipbuilding and Dry Dock Co.

Gatineau Power Co Adds 34,000-hp Unit

Gatineau Power Co has completed installation of a new 34,000-hp generator in its Chelsea hydroelectric plant on the Gatineau River in Quebec. This is the fifth unit of similar capacity in the plant and completes the station to its full designed capacity of 170,000 hp. Cost of the new generator was financed from current cash funds.

Seven miles north of Ottawa, the Chelsea plant is one of four which the Company has on the Gatineau River with total installed capacity of 506,500 hp. In two of these power houses, there is space for two additional generators totaling 58,000 hp.

With installation of the new generator at Chelsea, Gatineau Power Co has a total installed generating capacity in all its hydroelectric plants of 716,634 hp, of which 608,684 hp is in interconnected plants on the Ottawa River, Gatineau River and other tributaries of the Ottawa.

Eastern Utilities Buy Three Turbines

Looking ahead to the future, two major utilities recently placed orders for a total of 180,000 kw of turbine-generators.

Philadelphia Electric Co has purchased a 50,000-kw, 3600-rpm superposed turbine for the Chester station from General Electric Co. Steam will be supplied to the turbine at 1250 lb and 925 F, and exhausted at approximately 265 lb for use in the existing units.

The generator will be 60-cycle, 3-phase, capable of carrying 62,500 kva at 80% power factor, with a terminal voltage of 13,800, and will be hydrogen-cooled.

Consolidated Edison Company of New York, Inc, has purchased one 65,000-kw unit from General Electric and one 65,000-kw unit from Westinghouse Electric & Manufacturing Co. At present, negotiations are in progress for purchase of boiler and other equipment. The units are for installation in Waterside station. A 53,000-kw unit was installed last year.

Consumers Power to Spend $16,000,000 on Construction

Consumers Power Co plans to spend $16,000,000 this year on new construction and improvements to present system. Chief among proposed projects are completion of the John C Weadock plant at the mouth of the Saginaw River near Bay City, Mich., and expansion of the Bryce E Morrow plant on the Kalamazoo River near Comstock, Mich.

Work on the Morrow plant was started last year and is expected to be completed some time this spring. Plans call for two 35,000-kw units. Optimism is reflected in the decision to renew work on the John C Weadock plant, which was suspended last year. This plant, to have an installed capacity of 35,000-kw, is scheduled for first operation in the spring of 1940. Provisions are being made for another 35,000-kw unit to meet load growth.

Addition for Buzzard Point

Construction work for installation of a turbine-generator and one boiler in the Buzzard Point plant will be undertaken in the near future by Potomac Electric Power Co.

The construction budget for 1939 totals

JONAH AND THE WHALE OF A CASING

This mammoth casing belongs to one of four 20,000-hp hydraulic turbines that Allis-Chalmers is building for Grand River Authority, Pensacola Dam, near Vinita, Okla. These units will operate at 115-ft head. Speed ring, in right foreground, is about 17 ft in diameter and weighs 36,000 lb

approximately $10,300,000, of which $5,800,000 is provided for expenditures this year and $4,500,000 for new projects started this year but scheduled for completion in 1940. This compares with $5,130,000 spent during 1938.

Actual size of the turbine to be installed in the Buzzard Point plant has not been finally decided. During 1938 the company completed the major addition to its Buzzard Point plant with installation of a 35,000-kw turbine-generator which went into commercial operation last September.

Open House at Yarnall-Waring

Fifty were expected, 120 came to the Yarnall-Waring's "Open House" on the evening of March 7 at Chestnut Hill, Philadelphia, Pa. A large delegation of Philadelphia engineers, with others from Trenton, Reading, Wilmington (Del.), New York and other neighboring cities, inspected the manufacturing plant in full operation and studied new developments in the high-pressure laboratory. Visitors watched the testing of a 1200-lb impulse trap destined for a Detroit Edison plant. They also saw other new developments not yet ready for announcement.

Factory demonstrations included the Stelliting of high-pressure blowoff-valve seats and disks, pressure and temperature testing of blowoff valves, use of microphone and loudspeaker to set impulse traps, drilling of large hexagonal holes in hard alloy valve seats, delicate swedging and grinding operations, and a great variety of machining operations, heavy and light.

BUSINESS ITEMS

CLARK CONTROLLER CO, Cleveland, Ohio, has acquired control of the Invex Corp, Bethlehem, Pa., electrical research organization. Invex will remain corporate, headed by W H Williams, also vice-president and sales manager of Clark, together with Palmer H Craig, vice-president. Invex Corp moves to a new building addition of the Clark plant. Research on Clark lines will be continued by previous personnel and new supplemental lines will be created.

OAKITE PRODUCTS, INC, New York, N. Y., commemorated its 30th anniversary with a special issue of Oakite News Service, which gives a historical review of industrial cleaning methods and trends.

FLUOR CORP, LTD, Los Angeles, Calif., announces that it has acquired The Cooling Tower Co, Inc, New York, N. Y. No immediate changes in sales or distribution divisions of either company contemplated.

WHEELCO INSTRUMENTS CO, Chicago, Ill. announces appointment of C W Lugar to Indianapolis territory at 216 Indianapolis Terminal Warehouse, Indianapolis, Ind. Formerly with Minneapolis-Honeywell Co, Mr Lugar has a B S degree in Mechanical Engineering and served as engineer in Extension Service of Purdue University.

UNITED CONVEYOR CORP, Chicago, Ill., has appointed district sales representatives T E Nott, 22 Brevard Court, Charlotte, N. C., and W D Taulman, 175 Spring St, Atlanta, Ga.

D Robert Yarnall demonstrates 1200-lb impulse trap built for Detroit Edison

WAILES DOVE-HERMISTON CORP, New York, N. Y. announces appointment, as distributors of Bitumastic protective coatings, Branche-Krachy Co, Houston, Tex.; R W Hudgins & Son, Norfolk, Va.; James Walker Co, Baltimore, Md.; and Industries Supply Co, San Diego, Calif.

STEARNS MAGNETIC MFG CO, Milwaukee, Wis., announce appointment of W E Craner as representative in Houston, Tex.

WARD LEONARD ELECTRIC CO, Mt Vernon, N. Y., announce change in address of agent, Mark G Mueller. New address is 1644 Blake St, Denver, Colo. Mr Mueller represents the company in Colorado, Western Nebraska, Northern New Mexico, and almost entirety of Wyoming.

COCHRANE CORP, Philadelphia, Pa., has appointed O H Woolford Sales Manager for Specialties and Meters, relieving A B Wallem. S D Distelhorst, formerly with *Air Conditioning & Oil Heat*, will handle advertising and sales promotion.

W W SLY MFG CO, Cleveland, Ohio has appointed Snyder Engrg Corp, Los Angeles, Calif., as representative. Company operates in Los Angeles and San Francisco.

JOHN J NESBITT, INC, Holmesburg, Philadelphia, Pa., has erected an addition to its plant because of expanding business. The brick and concrete structure consists of two bays, giving an additional 15,000 sq ft of floor space that will be used in manufacturing a special extended copper heat-transfer surface.

OBITUARIES

HERBERT A JOHNSON, United States representative of the Leipzig Trade Fair died in New York recently.

CHARLES A TERRY, 80, honorary vice-president of Westinghouse Electric & Mfg Co, died recently in New York. He had been retired several years. Born March, 1858, in South Weymouth, Massachusetts, he became vice-president of the Westinghouse Company in 1909. He held this position until April, 1931, when he became honorary vice-president. Mr Terry was one of few remaining men who had worked with and knew George Westinghouse.

FRED H KEY, 70, vice-president and general manager of the Key Co, East St. Louis, died in February at De Paul Hospital, St. Louis. Born in Auburn, Ky., he came to St. Louis about 30 years ago, and formed Key Co in 1916. Mr. Key was a member of the American Society of Engineers and Masonic Society.

JAMES MCALEAR, president of McAlear Mfg Co, Chicago, Ill. passed away recently after a two months illness. Born in Canada, he came to this country as a boy, and was graduated from Purdue University. Mr McAlear was with B Sturtevant for some time before starting out as consulting engineer for himself, and was retained by several states for public buildings.

JOHN R BURNETT, president of the Rollins Engine Co, Nashua, N H., died in a hospital there after a short illness. He was born in that city in 1874.

PERSONALS

JAMES E BEVAN has been appointed assistant chief engineer of the Roller-Smith Co, Bethlehem, Pa. Mr Bevan has been with the company since 1928, when he left the Philadelphia Electric Co, Philadelphia,

Meetings

Annual Anthracite Conference—*April 28–29, Packard Memorial Hall, Lehigh University, Bethlehem, Pa. Prof Howard Eckfeldt, chairman, Committee on Arrangements, Lehigh University.*

American Institute of Electrical Engineers—*Combined Summer and Pacific-Coast Conventions, June 26–30, San Francisco, Calif. H H Henline, secretary, 33 West 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*45th Semi-Annual Meeting, July 2–5, Grand Hotel, Mackinac Island, Mich. A V Hutchinson, secretary, 51 Madison Ave, New York, N. Y.*

American Society of Mechanical Engineers—*Oil and Gas power Division Meeting, June 19–22, Ann Arbor, Michigan. Also, Semi-Annual Meeting, July 10–14, San Francisco, Calif. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Refrigerating Engineers—*26th Spring Meeting, May 22–23, Hotel Hershey, Hershey, Pa. Headquarters office, 37 W 39th St, New York, N. Y.*

Midwest Power Conference—*April 5–7, Palmer House, Chicago, Ill. Stanton E Winton, Conference secretary, Armour Institute of Technology, 3300 Federal St, Chicago.*

National District Heating Association—*Annual Meeting, June 27–30, Hotel Pennsylvania, New York, N. Y. W H Sanford, secretary, 1317 Spruce St, Philadelphia, Pa.*

Smoke Prevention Association—*33rd Annual Convention, June 13–16, Hotel Schroeder, Milwaukee, Wis. C D Behan, publicity director, SPA, City Hall Square Bldg, Chicago, Ill.*

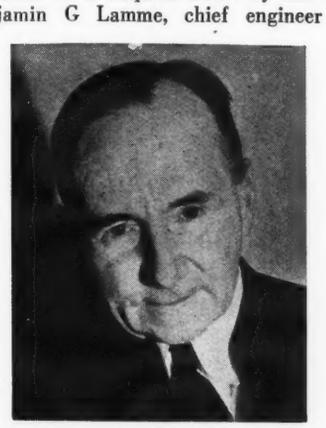
Stoker Manufacturers Association—*Annual Convention, June 1–2, French Lick Springs, Ind. Assn headquarters, 307 N Michigan Ave, Chicago, Ill.*

Pa. For two years he was engaged in plant efficiency work and from 1930 to 1933 was connected with the Roller-Smith New York sales office. From 1933 to the early part of 1939 he was Switchgear Specialist of the company at Bethlehem.

FREDERICK W COPELAND was elected president of Sullivan Machinery Co, East Chicago, Ind. Mr Copeland resigned the presidency of the H Channon Co, Chicago, to accept the position. He was formerly connceted with Sullivan Co, having joined the organization in 1913, and has worked as apprentice, serviceman, salesman, export manager, vice-president and controller. H T Walsh, J W Haddock, W R Jarivs, and L T Noel were elected directors.

C H BECKWITH has been appointed district manager of Chicago sales territory of Pittsburgh Piping & Equipt Co, Pittsburgh, Pa. Mr Beckwith came to the Pittsburgh Co from Crane Co, where he has been a special representative for the past 19 years. Mr Beckwith will have offices in Peoples Gas Bldg, Chicago, and General Motors Bldg, Detroit.

MARION A SAVAGE, designing engineer, General Electric Co, has been awarded the 1938 Lamme Medal of the American Institute of Electrical Engineers, "for able and original work in the developement and improvement of mechanical construction and efficiency of large high speed turbine alternators". The medal, originally given as result of a bequest made by the late Benjamin G Lamme, chief engineer of



Marion A Savage

Westinghouse Electric & Mfg Co, who died July 8, 1924, will be presented to Mr Savage at annual summer convention of Institute, on June 26-30, 1939 in San Francisco, Calif. Mr Savage has been with General Electric Co since graduation from Clemson College in 1906. He developed and built two of this country's largest generators, now running in Hudson Ave Station of Consolidated Edison Co, rated 200,000 kva, 16,500 volts.

EDWIN L DENNIS is now connected with the Coppus Engrg Corp, Worchester, Mass, as chief combustion engineer. He is graduate of L S U School of Engineering and for twelve years was the chief engineer of Godchaux Sugars, Inc, New Orleans, La. Mr Dennis is the inventor of the Coppus-Dennis "Fanmix" rotary gas burner.

WILLIAM A LEWIS, JR, has been appointed director of the School of Electrical Engineering, Cornell University. He was formerly engineer with Westinghouse Electric & Mfg Co, Pittsburgh, Pa.

SCHOOL FOR STEAM CAREERS

A group of Port Washington Station operators listen to Professor Ben Elliott, University of Wisconsin, at a late-afternoon lecture. A 15-weeks course was given the past winter on modern power-plant practice by The Milwaukee Electric Railway Co. in cooperation with the U of Wisc. and several manufacturers. Cost of the course was financed by the Port Washington city council

FRANK L NASON, former manager of the Central Station Department of Westinghouse Electric & Mfg Co, Boston, has been appointed New England district manager, succeeding the late James P Alexander.

KENNETH A RARICK has been appointed sales manager of Johnston & Jennings Co, Cleveland, Ohio, in the midwestern territory. Mr Rarick is graduate of Purdue

Kenneth A Rarick

University, and spent much time in combustion engineering. His offices will be in the Chicago plant, 1030 West 38th St.

STRAWS

Pointing the way business winds blow

ARIZONA——Dept of Interior, Indian Service, Washington, D. C., will contract for central-heating and power plant at Navajo Indian Agency, Fort Defiance, including two high-pressure boiler units, stokers, combustion controllers, water-softening apparatus, coal-handling equipment, and 75-kw generating unit.

ARKANSAS——Bd of Polk County Commissioners, Mena, plans central-heating plant in 3-story courthouse and jail. Cost about $490,000. Haralson & Mott, Merchants' National Bank Bldg, Fort Smith, architects.

State Dept of Institutions, Little Rock, plans improvements in central-heating plant at state hospital. Fund of $117,000 has been authorized.

State Bd of Education, Little Rock, will contract for central-heating plant at state teachers' college, Conway, in conjunction with other buildings at institution. Cost about $300,000. Wittenburg & Delony, Pyramid Bldg, Little Rock, architects.

CALIFORNIA——Fallbrook Public Utility District, Fallbrook, contracted Pacific Enterprise Co, Los Angeles, for diesel-operated pumping plant for water system improvements, at $18,755.

East-West Dairymen's Association, Newman, plans milk products plant, consisting of three 1-story buildings. Boiler house proposed. Cost about $150,000. Ernest J Kump, Rowell Bldg, Fresno, architect.

Pacific Can Co, Williams and Newhall Sts, San Francisco, plans 1-story addition, 75 x 205 ft. Cost about $100,000. W H Ellison, Pacific Bldg, architect and engineer.

Wasco Public Utility District, Wasco, plans pumping station for water system on Griffith Ave. Cost about $40,000.

Yosemite Portland Cement Corp, 564 Market St, San Francisco, plans improvements in mill at Merced.

State Dept of Public Works, Sacramento, has low bid from A-1 Ice Machine Co, 3515 W Washington Blvd, Los Angeles, at $31,572.25 for equipment for ice-manufacturing and cold storage plant at State Home, Sonoma. Contract will be awarded soon.

Procurement Division, Public Buildings Branch, Treasury Dept, Washington, D. C., plans central-heating plant in 3-story parcel post building, 275 x 550 ft, at Mission and Howard Sts, San Francisco, for which bids are being asked on general contract until April 18. Cost about $2,000,000.

Dept of Interior, Indian Service, 523 Eighth and Figueroa Bldg, Los Angeles, plans 3-unit electric-operated pumping station at St Ignatius, Mont., in connection with Flathead Indian Irrigation project, each unit to have rated capacity of 67 cu ft per sec. A 4-ft dia steel pipeline will be installed.

COLORADO——Citizens Utilities Corp,

La Junta, plans extensions in pipeline system for local gas distribution. Cost about $25,000.

CONNECTICUT——Pratt & Whitney Div, Niles-Bement-Pond Co, Hartford, will take bids soon for 1-story plant, 520 x 960 ft, in Charter Oak Park district, for manufacture of machine and small tools, with 2-story adjoining unit for executive service, 150 x 242 ft. Power house will be built. Project will cost over $1,500,000. Albert Kahn, Inc, New Center Bldg, Detroit, Mich., architect and engineer.

School Bd, East Hampton, plans central-heating plant in two-story addition to central high school. Project will cost $200,000. Leo F Caproni, 1221 Chapel St, New Haven, architect and engineer.

FLORIDA——Southern Hotel Co, Miami, care of J N Morris, Seybold Bldg, attorney and representative, plans central-heating plant in multi-story hotel. Cost about $200,000.

Merchants Cold Storage Co, Richardson and Conroy Sts, Jacksonville, plans improvements, including series of individual cold-storage vaults. Cost over $40,000.

Sun Dine Packing Co, Sunset Theater Bldg. Fort Lauderdale, plans boiler house in fruit-canning plant at Davie Blvd., and line of Seaboard Air Line R.R. Cost $45,000. Guy P Johnson, Sweet Bldg, architect.

Bd of Commissioners of State Institutions, Capitol Bldg, Tallahassee, plans power plant at Florida state hospital at Chattahoochee, and will soon make equipment awards. Cost over $100,000. A P Michaels, Orlando, consulting engineer.

GEORGIA——Augusta Housing Authority, Marion Bldg, Augusta, H R Powell, manager, plans central-heating plant in Sunset Homes development at Jefferson Davis Ave and Linder St, consisting of group of 23 buildings. Cost about $520,000. Merry & Parsons, S F C Bldg, Augusta, architects.

W Frank Upchurch, president, Upchurch Packing Co, Atlanta, meat packer, heads company being organized to construct and operate distillery. Consists of several units with power house. Cost over $200,000.

IDAHO——Northwest Cities Gas Co, Lewiston, plans improvements in gas plants at Lewiston and Pendleton, Ore. Cost about $40,000. Artificial gas plant being considered at Clarkston, Idaho.

ILLINOIS——Bd of Education, 228 North LaSalle St, Chicago, will take bids for boiler plant at Bowen high school, E 89th St. Project will cost $400,000. John C Christensen, address noted, architect for board.

Bd of Education, Rockford, plans central-heating plant in multi-story senior high school. Cost over $1,000,000. Bids will be asked early for general erection. G A Johnson, architect for board.

Quartermaster Corps, Fort Sheridan, plans central-heating plant with stoker-fired boiler units in 3-story and basement hospital and medical barracks. Cost about $785,000. To ask bids in July.

Sears, Roebuck & Co, Chicago, plans central-heating plant in 2-story and basement department store at Pico and West Blvds, Los Angeles, Calif. Complete air-conditioning system will be installed. Cost about $1,500,000. Nimmons, Carr & Wright, 333 N Michigan Ave, Chicago, architects.

Farmers' Co-operative Creamery Co, Elizabeth, John F Allen, president, plans 1-story cold-storage and refrigerating plant, with locker system. Cost about $35,000.

INDIANA——Rushville contracted Worthington Pump & Machinery Corp for turbine-generator unit and accessories at $50,100 for installation in power plant. Also made award to Ross Heater & Mfg Co, for surface condenser, at $21,305; for boiler unit to Wilkes Boiler Co; for stoker to Laclede Stoker Co. Bevington-Williams, Inc, Indiana Pythian Bldg, Indianapolis, consulting engineer.

Bd of Directors, Fort Wayne State School, State St, Fort Wayne, will make improvements in power house at institution. Cost reported close to $40,000.

Peru takes bids soon for improvements in power plant, including 1-story addition, 40 x 104 ft. Cost reported over $75,000. H E Norris, City Hall, city engineer.

RCA Mfg Co, 501 N LaSalle St, Indianapolis, plans power house for addition to radio equipment-manufacturing

(*Continued on page* 150)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ariz., Fort Defiance — Bids Mar. 24, by Purchasing Officer Dpt. Interior, Wash., D. C., constructing central heating and power plant on Navajo Indian Reservation.

Conn., Stratford—Chance Vought Sikorsky Div. of United Aircraft Corp., Lordship, Stratford, plans by Albert Kahn, Inc., New Center Bldg., Detroit, and soon takes bids constructing brick, steel, concrete aircraft manufacturing unit. $300,000.

Del., Seaford—E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington, will construct brick buildings 300,000 sq. ft. floor space, for manufacturing Nylon thread. Owner builds. $8,000,000. Work under way. Private plans.

Ill., O'Fallon—Perry Coal Co., Boatmen's Bank Bldg., St. Louis, Mo., plans repairing damage to power plant of St. Ellen coal mine, repairing engine room and generator room and to 2 generators, 2 transformers, hoisting equipment, on U.S.H. 50, near here. $75,000.

Ind., Indianapolis—General Motors Corp., General Motors Bldg., Detroit, sketches by L. Allen, 635 Architect & Builders Bldg., constructing plant for manufacturing airplane motors. $12,000,000. Owner seeking site west of Indianapolis near Municipal Airport. Realtors now negotiating for site.

Ind., Peru—Bd. P. Wks., H. E. Worl, clk., City Hall, soon takes bids constructing 1 story, 48x104 ft. brick, stone, rein.-con., steel power plant. $30,000. H. E. Norris, City Hall, engr.

Ind., Rensselaer—Bd. P. Wks. making sketches constructing power plant improvements, and additions. $45,000. J. W. Moore & Son, 834 Ind. Pythian Bldg., Indianapolis, consult. engrs.

Ia., Anita—Bids Mar. 29, by Town, constructing electric light and power plant and distribution system, power plant building. 2 diesel engines, etc. $110,000. Young & Stanley, Inc., Muscatine, engrs.

Ia., Chariton—City defeated $98,000 bonds constructing power plant and distribution system. G. McCarthy, Chariton, engr.

Ia., Montezuma—Election Apr. 7 to vote on proposal to construct electric light and power plant and distribution system. $136,000.

Ia., New Hampton—A. Griffith, city clk., preliminary survey constructing municipal light and power plant improvements, diesel engine and miscellaneous equipment. R. D. Thomas & Assoc., 1200 2nd Ave., Minneapolis, Minn., engrs.

Ia., Renwick—Bids Apr. 10, by Town, constructing extensions to municipal light and power plant, new diesel engine with 260 hp. with generator, exciter, accessories and auxiliary equipment. Over $25,000. Young & Stanley, Muscatine, engrs.

Ia., Sumner—Bids Apr. 12, by City, H. W. Bathke, clk., improving municipal light and power plant, incl. diesel engine, generating unit, complete with exciter, alternator and other auxiliary equipment, switchboard, panel with switchboard instruments, etc. R. W. Gearhart, 349 21st St., Cedar Rapids, engrs.

Ia., Villisca—A. S. Harrington, engr., Baum Bldg., Omaha, Neb., preparing plans and expects to ask for bids about Mar. 25 to be opened about Apr. 21, constructing power plant improvements, for City. $65,000.

Ia., Woodbine—City c/o City Clerk, making preliminary surveys constructing municipal light and power plant and distribution system. J. Harrington, Omaha, Neb., engr.

Kan., McPherson—City plans installing 5,000 kw. turbine, additions to power plant building and cooling tower. $400,000. Burns & McDonnell, 4706 Bway., Kansas City, Mo., engrs.

Ky., Owensboro—Bids Mar. 21, by City, constructing Contr. 9, water and light plant structures, foundations, $570,700; Contr. 10, intake structure and foundations, $214,700; Contr. 11, switch gear, $112,000. Part of $2,313,370 PWA project. Black & Veatch, 4706 Broadway, Kansas City, Mo., engrs.

Mass., Worcester—Coco Cola Co. of Mass., 30 Washington St., Boston, revised plans by J. M. Shelton, Bona Allen Bldg., Atlanta, Ga., constructing 1 and 2 story basement bottling plant. $100,000. Bids Jan. 26, rejected.

Mich., Marquette—City Com. retained Holland, Ackerman & Holland, Ann Arbor, to prepare plans rehabilitating power plant, incl. new penstocks, equipment, etc. $185,000.

Minnesota—Northern States Power Co. of Minnesota, R. F. Pack, 15 S. 15 St., Minneapolis, 1939 construction program includes constructing 2 story service station addition 16th and Chestnut Sts., installing additional equipment at Garfield, Penn. and Terminal substations, increasing transformer capacities in downtown and industrial districts, all foregoing in Minneapolis; new high voltage line, extending other lines and installing new equipment in St. Paul, by company forces. $4,553,000.

Neb., Laurel—City plans purchasing new diesel engine and repairing power plant building. $19,000. R. Creamer, Light Comr.

Neb., Lincoln—Bids Mar. 22, by City, constructing power plant improvements at A St. generating plant. Total est. $175,000. PWA. Black & Veatch, Kansas City, Mo., engrs.

Neb., North Platte—City election Apr. 4, to vote $360,000 bonds constructing municipal electric power distribution system. R. F. Nosky, city engr.

Neb., Omaha—Paxton & Vierling Iron Wks., 17th St. and Union Pacific R.R. tracks, constructing new plant, Locust St., East Omaha, own labor. $125,000. Private plans.

N. Y., Binghamton—State Dpt. Mental Hygiene, State Bldg., Albany, plans constructing new power plant for State Hospital. $830,000. W. E. Haugaard, comr. Architecture, archt., and T. F. Farrell, ch. engr. Dpt. P. Wks., engr., both State Bldg., Albany.

N. Y., New York—Pavonia Building Corp., 140 Cedar St., altering 7 story manufacturing building, garage and power house, 141-51 E. 25 St. Owner builds. $40,000. W. Miltenberger, 551-5 Ave., New York, archt.

N. C., Cliffside—Duke Power Co., 430 S. Church St., Charlotte, constructing steam power plant, 80,000 kw. generating capacity, Broad River, own forces. Two boilers, to Combustion Eng. Co., 200 Madison Ave., New York City; two 40,000 kw. turbine generators, to General Electric Co., River Rd., Schenectady, N. Y. Total est. $7,500,000.

N. C., Plymouth—North Carolina Pulp Co., H. M. Kieckhefer, secy.-treas., c/o Kieckhefer Container Co., Delair, N. J., plans constructing new unit at plant, also homes for 150 employees. $800,000-$1,000,000.

O., Amherst—Bd. Pub. Affairs, voted to construct municipal light plant. $100,000. WPA.

O., Eaton—Village plans constructing light plant. $200,500. Collins Wight, 920 Union Trust Bldg., Dayton, consult. engr.

O., Monroeville — City plans constructing power plant. $78,000. C. H. Zipfel, mayor.

O., Zanesville—Zanesville Concrete Pipe Co., Zanesville, plans constructing plant for manufacture of concrete pipes. $100,000. Maturity in spring.

Ore., Portland—Portland Electric Power Co., F. T. Griffith, pres., Electric Bldg., will spend $1,650,700 on new construction and maintenance during 1939, transmission lines, distribution lines, new 1 mi. flume from Cazadero Dam to Faraday, Clackamas Co., to power house, reconstructing Cazadero Dam, new fish ladders, etc.

Virginia—Virginia Electric & Power Co., 7 and Franklin Sts., Richmond, plans expending $6,144,595 on improvements during 1939, incl. 40,000 kw. power house addition 12th St., $3,409,758, trolleys and buses, $443,700. Norfolk will receive $182,950 for replacements in company's gas dpt., $161,545 for general improvements, and $200,000 for 200 mi. rural electric lines. Norfolk Dist. will receive $1,985,350.

Va., Richmond—United States Tobacco Co., 4325 West 5 St., Chicago, Ill., plans constructing plant, Petersburg Pike. $1,250,000. T. Clark, 25 S. 19 St., Richmond, company engr.

W. Va., Belle—E. I. du Pont de Nemours & Co., du Pont Bldg., Wilmington, Del., will construct 15,000 sq. ft. brick plant, by own forces. $2,000,000. Construction under way.

Wis., La Crosse—Northern States Power Co. of Wisconsin, 15 S. 5 St., Minneapolis, Minn., 1939 construction program includes steam electric generating plants, here, the largest single item in whole program by company forces. $2,322,000.

B. C., New Westminster—Municipality making plans constructing municipal electric power plant. H. E. Meyers, Vancouver, engr.

B. C., Prince Rupert—Northern B. C. Power Co., Ltd., J. J. Little, mgr., plans constructing power house at Shawatlans Lake, of two 5,000 hp. units, instead of at present plant of 1,200 hp. $750,000. Private plans.

B. C., Vancouver—Ormonds, Ltd., J. E. Ormond, gen. mgr., making plans constructing biscuit factory, Mary St. $85,000. Private plans.

Ont., Chesterfield—Lardner Lake Gold Mines, Ltd., c/o Col. J. Gordonweir, 272 Forrest Hill Rd., Toronto, soon takes bids constructing 500 ton mill, with provision for increase to 750 tons daily. $400,000.

Ont., Sarnia—Syndicate, c/o H. Lockhart, Chamber of Commerce, 197 N. Christina St., plans constructing sugar beet refinery. $100,000. Negotiating for site.

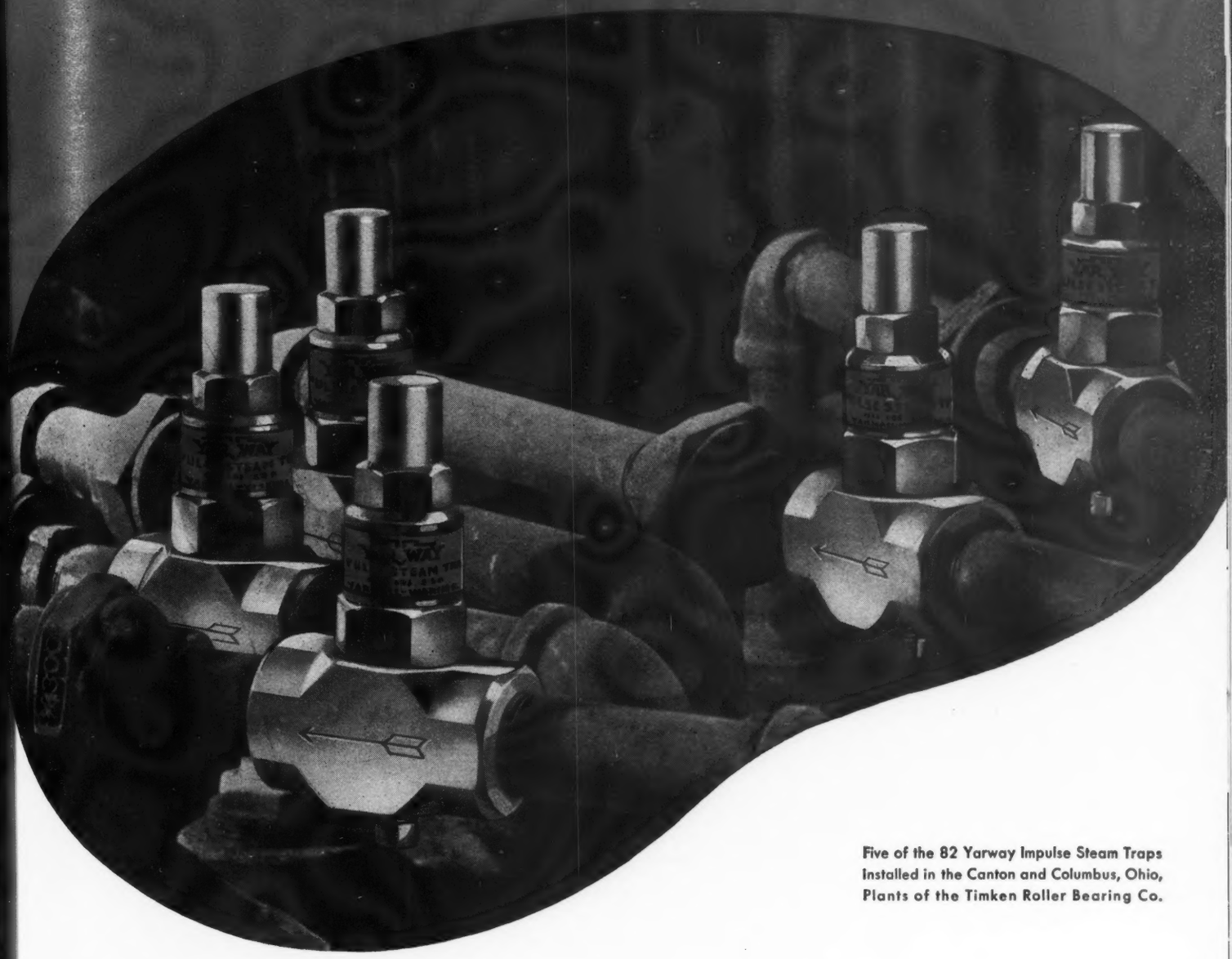
Ont., Toronto—Falconbridge Nickel Mines Ltd., J. G. Hardy, pres., 25 King St. W., plans constructing refinery. To exceed $250,000. Maturity in summer.

Ont., Toronto—Gerrie Tobacco Co. Ltd., F. Raney, K.C., secy., 465 Bay St., plans constructing plant. $75,000. Maturity in spring.

Que., Magog—Municipality, A. Girard, clk., plans constructing refinery. To exceed $250,000. Maturity in summer.

Sask., Regina—Scientific Equipment Laboratories Ltd., R. W. Ross, mgr., plans constructing plant for extraction of oil and other products from Alberta tar sands, 25 tons daily. $75,000. Private plans.

82 YARWAY IMPULSE TRAPS *Serve* TIMKEN



Five of the 82 Yarway Impulse Steam Traps Installed in the Canton and Columbus, Ohio, Plants of the Timken Roller Bearing Co.

THE world rolls on Timken Bearings. And Yarway Impulse Steam Traps are proud to have a hand in their manufacture —by providing more efficient operation of steam equipment in Timken's Canton and Columbus, Ohio, plants.

More than 50,000 Yarways have been installed

The list of Yarway-equipped plants reads like a "Who's Who" of American Industry. Yarway Trap performance talks. Quicker heating and greater sustained heating efficiency soon pay for the installation and continue to return worthwhile profits in plant operating economy. When you consider that their purchase price is usually no more than the cost of repairing an ordinary trap—why not get Yarway performance for your money?

Install a Yarway Impulse Trap or two and let them demonstrate what they can do for you in speeding production and saving fuel.

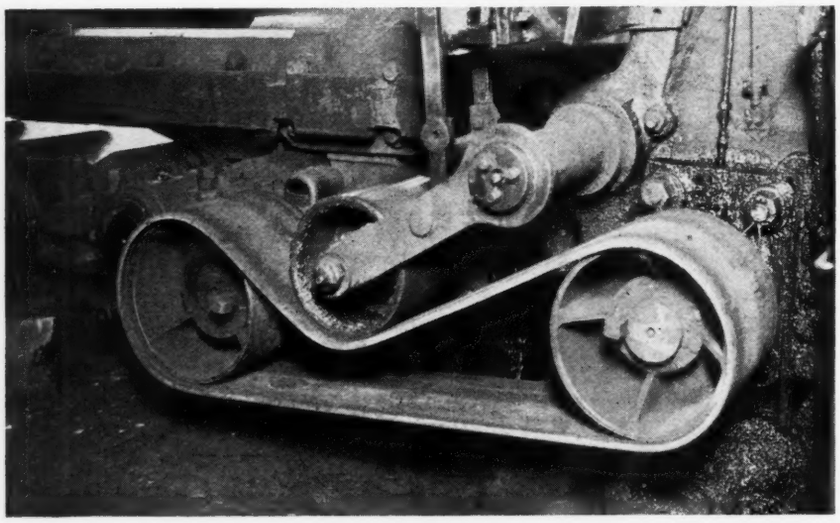
See how its small size saves space. How its light weight simplifies installation. How its unique design with only one moving part, and its rugged bar-stock construction, keep down maintenance expense. Then too, Yarway Traps are *suitable for wide range of pressures without change of valve or seat.*

A nearby Mill Supply Dealer handles Yarway Impulse Traps and will be glad to serve you. Or write for Catalog T-1734.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia

YARWAY IMPULSE STEAM TRAP

Practical Aids to Operation



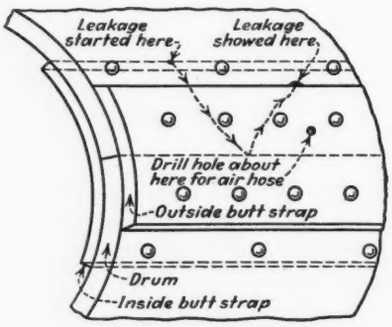
Special Belt Cures Drive Troubles

A LARGE STEEL company in the Pittsburgh area was faced with a serious belting problem on drives for large steel rolls which were frequently stalled by the ingots. The rolls are connected with a belt that runs on 20-in. diameter pulleys. Slippage on the driving pulley was prevented by the use of a rosin compound, which had been found necessary when a change in mill practice increased weight of the material.

Belt speed is approximately 400 fpm and is frequently subject to sudden reversals in direction. To add to the difficulties, the rosin compound covered only about two-thirds of the pulley, causing the belt to run off center. There was also an irregular build-up on the pulley due to pieces of rubber-belt cover adhering to the rosin compound. In addition, the belt was subjected to machine oil, grease, and to water used for cooling the rolls. Conditions were such that the best service obtained from any belt was 5 days.

Belting engineers, called in to make a study of the drive, recommended that a wider and heavier belt of special design be substituted for the 10 in., 8-ply, stitched, rubber-covered one then in use. As a result, a 16-in., 10-ply belt made of long-staple hard duck was installed as shown in the photograph. This belt is not stitched, nor rubber covered, and was made endless by the loop method because of the extremely high tensile strength required. The change completely eliminated the trouble and after 10 months use the belt is still in service. Belt cost has been reduced to a small part of what it was before the change, and costly production delays caused by belt failures have been eliminated.

Akron, Ohio P W VAN ORDEN
B F Goodrich Co



Tracing Boiler Leaks With Compressed Air

IT IS OFTEN difficult to trace initial source of leakage at a riveted seam, especially so in the case of butt- and double-strap-riveted boiler seams. Customary practice is to caulk the inside strap in order to reduce the possibility of embrittling salts accumulating under the straps. In the field, this is supplemented by caulking the outer strap if slight leakage occurs. This is effective, but it defeats the purpose of inside caulking.

The question arises then, if leakage at the outside caulking edge is observed, at just what point has the caulking edge of the inside strap failed? Seldom is it that the path of leakage takes the shortest distance between two points. Often, leakage at the caulking edge of the outside butt strap may enter past the caulking edge of the inner butt strap at a point several feet away along the seam. Rather than spend the time and trouble of recaulking the entire inside seam for one unknown point of leakage, a means of discovering this point may be used.

First, the outside butt strap is made tight against hydrostatic pressure by caulking. Then, at a point near the affected area, and about midway between the caulking edge and the abutting drum edges underneath, a $\frac{5}{16}$-in. hole is drilled through the outside butt strap. This hole is then threaded with a $\frac{1}{8}$-in. pipe tap.

A hose supplying air at 30 to 50 lb per sq in. is connected to this hole with a piece of $\frac{1}{8}$-in. tubing screwed into the butt strap. While air pressure is maintained, a man enters the drum and paints the caulking edges of the inside butt strap with soap suds. Bubbles from the compressed air leaking back through will indicate the point of leakage. This point should be marked for recaulking. Compressed-air pressure should be released during caulking operations.

Columbus, Ohio J R WILLIAMS

The Little Fellow Replaces the Big One

SOMETIMES a very small device can replace a large one and do as good or a better job. A case in point is that of protecting pressure switches and gages against surges on water systems. On

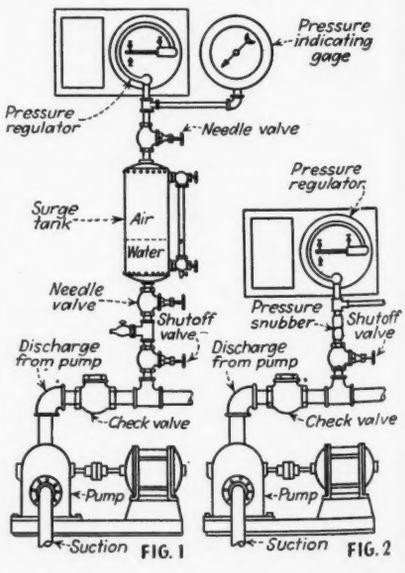


Photo News Valve values

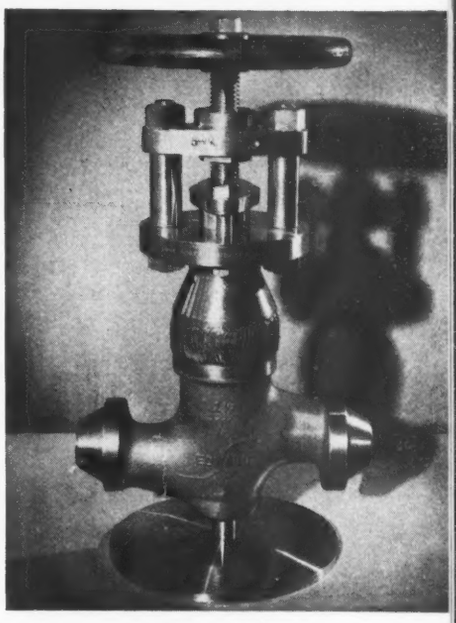
THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

EDWARD VALVES KEEP PACE WITH THE NEWS!

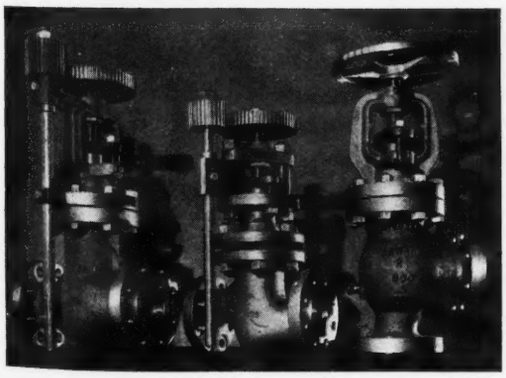
FOR AMERICA'S NEW MERCHANT MARINE, FOR THE STREAMLINERS OF THE GREAT WEST, FOR SUPER-POWER CENTRAL STATIONS, HIGH EFFICIENCY INDUSTRIAL BOILER HOUSES OR ULTRA-PRODUCTIVE REFINERY PROCESSES, EDWARD CAST OR FORGED STEEL VALVES KEEP IN STEP WITH THE TIMES. SOUND IN FUNCTIONAL DESIGN, THEY ARE EASILY ADAPTED TO HARD JOBS.

One thing all Edward valves have — basic fitness for tough service. Edward experience in high pressure and high temperature installations, accumulated through the years, provides a reliable background for steady, continuous progress. It is Edward engineering policy to go places — but without undue risk.

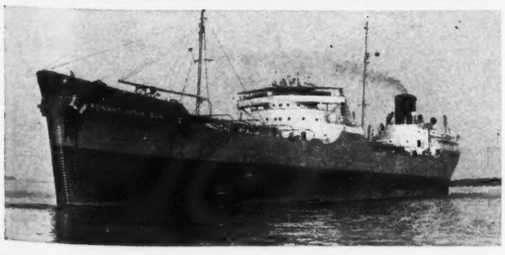
SEALED BONNET COMING? Welded joints in pipe lines have contributed to the peace of mind of boiler house operating men. Welding applications have gone much farther than boiler lines. They also are used extensively in refinery service, in cross country pipe lines and even on oil well casings. Naturally, therefore, operators ask why valves still need bolted bonnets. Answer is that foreign matter gets into pipe lines and too often causes troubles which necessitate the disassembly of the valves. Picture shows an Edward 1500 lb globe stop valve with Stellited seat and disk. The seat is welded in place in the body. Question is how to keep tramp metal out of lines.



5,000 hp. LOCOMOTIVE. New steam-electric unit, developed by General Electric and Union Pacific, for speeds to 125 mph, uses Edward valves. Boiler pressure 1500 lb at 920 F.

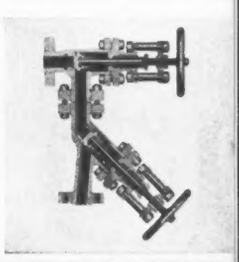


PEACE TIME HIGH. With first year contracts let for 51 ships, U. S. Maritime Commission activities have mounted to an all-time peace record. Edward valves are to be used on a majority of all vessels under construction, both motor and steam ships. Cut shows Edward marine valves—gear operated stop check, angle stop, cast and forged steel.

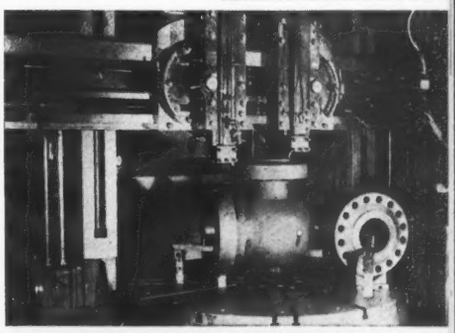


TANKERS USE EDWARD VALVES. Sensational progress in past few years in building high efficiency oil tankers has brought important additions to American shipping. This motorship uses a waste heat boiler.

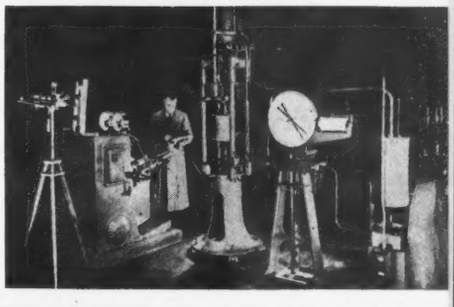
FORGED BLOW-OFFS. For all boiler pressures over 320 lb — for land service — Edward offers forged steel blow-off valves. Marine ratings are lower. For long continued operation at high pressures, without emergency shutdown, the disk type of blow-off valve has been found indispensable. Cross sectional view shows one of a number of optional arrangements of Edward blow-off valves in tandem. Seat and disk EValloy or Stellited.



BIG VALVE FOR TEXAS. Boring mill shown at right has 102 in. swing, but elbow inlet body casting, which is being machined, barely cleared the frame. This is a 12 in. 1500 lb sp non-return valve. Body and bonnet of nickel-chromium-molybdenum alloy cast steel.



SWISS TENSILE MACHINE. Getting the correct answer is the task of this formidable piece of Edward laboratory equipment, built to order in Amsler works at Schaffhouse. Results depend on extreme accuracy of temperature control, measurements of strain, and expert technique.



EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

such pressure systems, when the regulator switch closes and the pump starts and before water in the pipeline can be accelerated, pressure may become high enough to open the switch, unless regulator is protected against starting surges.

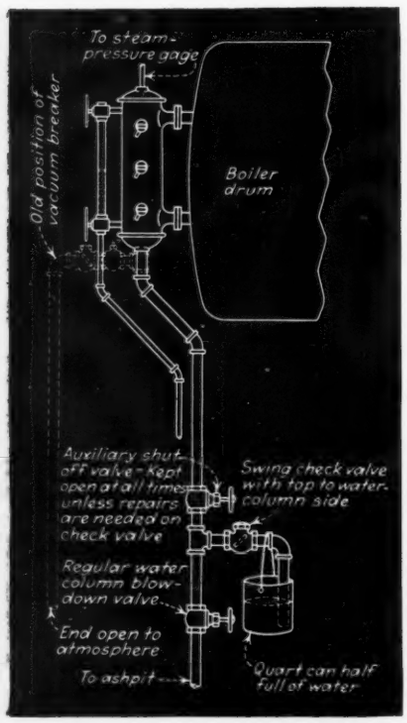
A surge tank installed between the discharge pipe and pressure switch, Fig. 1, is a common way of protecting the latter against surges. This tank is partly filled with air. Then, by throttling the needle valve so as to allow only a slow flow into the tank, air cannot be compressed sufficiently during a surge period to affect the switch. A surge tank is large and cumbersome. Air also gradually leaks out, allowing it to become water logged, making the tank ineffective as a surge absorber until again charged with air.

On several pumping systems, the surge tank has been replaced with Ray pressure snubbers, as in Fig. 2. This device takes practically no space and requires little or no attention. A small piston in it rises and falls with any sudden pressure changes in the system and prevents them from reaching the pressure regulator or gage.

Elmhurst, N. Y. R L HARRELL

Vacuum Breaker on Boiler

WHEN our boiler, which normally operates at 150 lb pressure, is shut down over weekends, we try to maintain 25-lb pressure on it. Sometimes the watchman was neglectful and let the boiler cool off, producing a partial vacuum in it. Letting the boiler stand for some time under this condition apparently caused leaking of handhole cover gaskets. To prevent this, a check-valve vacuum breaker was installed just below the water column, as indicated by dotted lines in the figure.


To steam-pressure gage
Old position of vacuum breaker
Boiler drum
Auxiliary shut-off valve—kept open at all times unless repairs are needed on check valve
Swing check valve with top to water-column side
Regular water column blow-down valve
End open to atmosphere
To ashpit
Quart can half full of water

After a considerable period of operation with the vacuum breaker just below the water column, where it was about 10 ft above the floor, we decided to bring it down where the check valve could be inspected without using a ladder. The new position is as indicated in the lower end of the blowdown line. This permitted us to add an improvement in the form of a quart can half full of water in which is immersed the vertical end of the vacuum-breaker pipe. The can serves two purposes: (1) if the check valve leaks the can fills with water, and (2) if the watchman allows the boiler to cool off, water will be drawn out of the can into the boiler, indicating the watchman's negligence.

When we first installed the vacuum-breaker, we were afraid to place it in the lower position for fear that head of water on the valve disk would prevent it from working properly. After two years' experience with the valve in the upper position we lowered it. Tests show satisfactory operation in both positions.

Englewood, N. J. R BOETTINGER

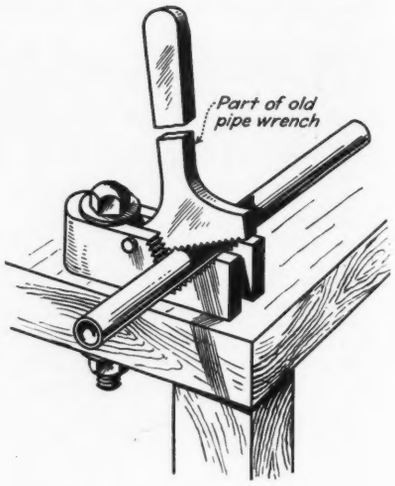
Don't Drop a Boiler

RECENTLY a large assembled box-header boiler was being moved to be set up in a new power plant. The boiler arrived on a flat car, and the riggers moved it into the boiler house. While it was being hoisted into place, a hoist rope failed and the boiler dropped about 6 ft onto a concrete floor, landing on its headers. No visible damage of serious nature could be seen, and all persons witnessing the accident agreed to proceed with the installation and say nothing.

Several weeks after the accident the boiler was ready for a hydrostatic test of 1.5 times normal working pressures. After the usual procedure of preparing the boiler for the test, it was filled with water. When the pressure was raised to about 50 lb per sq in., water sprayed from dozens of expanded tube ends and threaded staybolts, leaking out as fast as it could be pumped in.

An investigation disclosed the cause and showed the absurdity of covering up the accident. Needless to say, extensive repairs had to be made before the boiler could be tested and put into operation.

Cleveland, Ohio A C WIGGINS



Quick and Handy Small-Pipe Vise

OFTEN, in the course of overhaul work, we need quick-acting and handy devices, as for example, in removing a fitting from a piece of pipe, or making up temporary connections. The figure shows a small-plant-made fixture attached with one bolt to the work bench that does a lot of the work that most fellows try to do with two pipe wrenches. It permits easy and rapid handling of the parts.

Just drop the pipe in the fixture and pull the lever jaw while using the other hand to manipulate a pipe wrench. The idea was born from the desire to save the good part of a broken large pipe wrench. All we had to do was bend the U-shaped bench jaw from a piece of steel, cut some teeth in it and temper.

Penacook, N. H. C H WILLEY

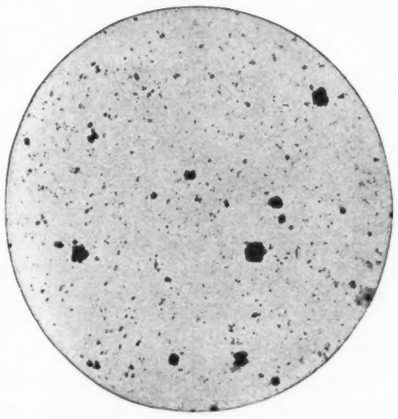
Drip-Piping Change Prevents Waste

THEORETICALLY, the perfect drip-piping layout is completely enclosed and will prevent loss of any hot condensation from the equipment it serves. To approach this ideal as nearly as possible, designers provide bypasses around traps so that there will be no apparent waste when the trap is taken out for repairs. Another practice motivated by the same thinking is to tie untrapped drips or free-blow lines arranged for manual control into the condensate-return piping. A typical totally enclosed system draining a reducing-valve as-

STABILIZED WATER

EVEN FOR TEMPERATURES UP TO 400°F.

BEFORE — This highly magnified view shows calcium carbonate crystals formed by heating water that has been softened, but not stabilized.



AFTER — Here is how the same water looks after being stabilized by Nalco treatment. It has been subjected to the same heat.

Prevents deposit of scale in feed-lines, pumps, heaters, feedwater regulators, high temperature closed heaters, and economizers in new high pressure, high rating plants.

IN steadily increasing numbers, industrial organizations all over the country are installing new high pressure, high rating steam generating plants for power and process service. In virtually every case, these plants need special treatment of feedwater to prevent scale formation during the pre-heating stages.

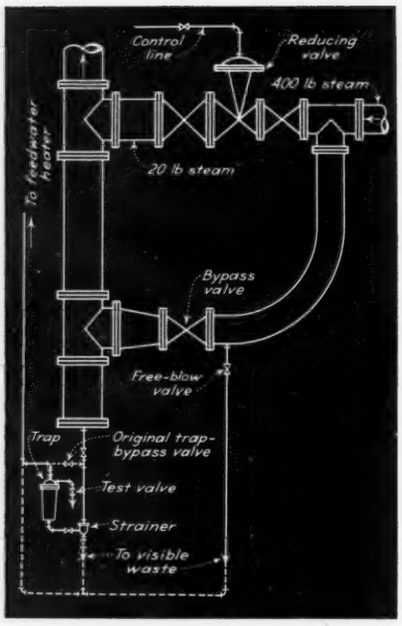
Nalco met this situation a number of years ago and developed exclusive treatment (*Nalco No. 8 and No. 18*) for stabilizing the feedwater during its passage through auxiliary equipment. Today, Nalco still leads in being able to give you water that is stable up to 400°*. Nalco products have also been used extensively for stabilizing water in cooling and hot water systems of every description.

For information, see your local Nalco field engineer, or write, NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Ill.

* Reaction is held back until the incoming feedwater mixes with the relatively higher concentrations in the boiler.

ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.



sembly is shown by the combined solid and broken lines in the drawing.

Practically, however, enclosing all drips leaves much to be desired. Trap bypass and manually operated condensate-drain valves have a habit of leaking or being inadvertently left open. When this happens, leakage of high-heat-level steam into the feedwater heaters often goes on for extended periods without being detected. Daily checking of all valves and traps in the return system, a procedure frequently given scant attention by operators, will effect some control over this waste. By far the best preventative is to remove trap bypasses and untrapped manually controlled drips from the return system altogether and pipe them to a drain where any leakage can be readily seen. The full lines in the figure show how this is done.

Condensation lost with this arrangement when traps must be worked on or when free-blow valves are opened, is relatively insignificant compared with possibilities of waste in the totally enclosed drip system. Although there is still the chance that the traps themselves will leak, this can be guarded against by installing test valves.

Roanoke, Va. S H COLEMAN

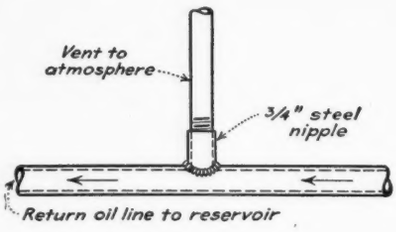
Draft-Gage Indicates Boiler-Room Pressure

OUR BOILER ROOM, containing two 5000-sq-ft boilers, is exceedingly cold in winter due to furnace waterwalls and well-insulated boilers. Even with three large radiators in service, the temperature in the boiler room becomes uncomfortable, as all air for combustion must come in through open windows. As this air amounts to nearly 500,000 cu ft per hr, with only one boiler in operation it means quite a generous opening of windows.

To get enough air for combustion and still not open more windows than necessary, an inclined draft gage was connected by a tube to the outside of the building, the other end being left open in the boiler room.

When the air pressure in the boiler room drops the slightest amount, it is indicated by a corresponding drop of fluid in the draft gage. This enables the operators to adjust the windows to admit enough air to keep the inside pressure nearly equal to that outside and room temperature at a more comfortable level.

Rochester, N. Y. H P KING



Vent Pipes Cure Oil Leaks

VENTILATION of many circulating oiling systems is provided for in the filler cap. If for any reason the cap makes an air-tight fit on the filler pipe, pressure builds up in the system and may cause oil leaks.

Removing the ventilating ribs from a filler cap in one case was found to be the cause of leaks in a lubrication system. Instead of reconditioning the filler cap, a ¾-in. nipple was welded into the return-oil line, as in the figure. A pipe screwed into the nipple served the double purpose of a vent and a thermometer well. A vent of this kind should be kept well away from hot steam lines or it may cause a fire. In our case, the vent cured a trouble that had existed for some time.

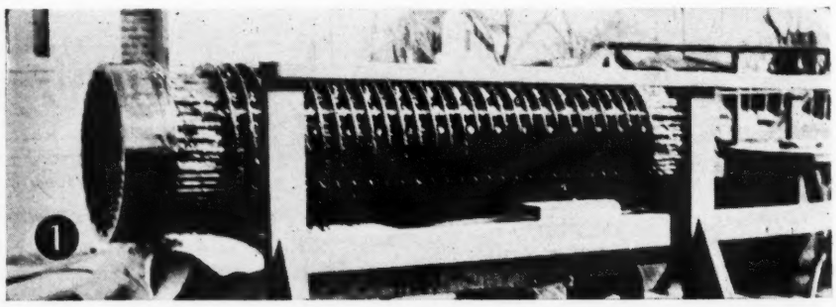
Fort Pierce Fla. T C CHEATHAM

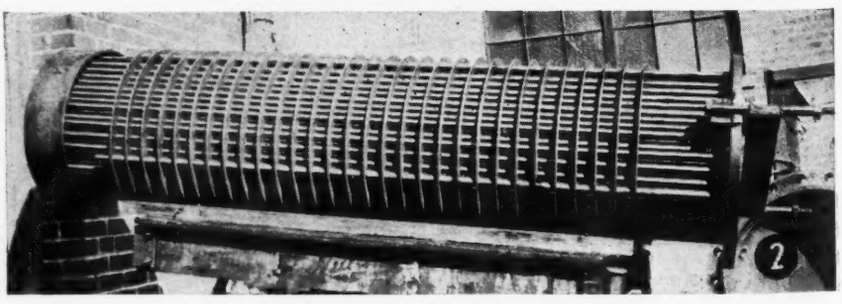
Difficult Cleaning Made Simple

CLEANING of heat-exchanger equipment frequently proves to be a troublesome problem, because of the nature and variety of the deposits that must be removed and the complicated surfaces which must be cleaned. Fig. 1 shows one of four shell-and-tube oil coolers before cleaning and Fig. 2 shows the appearance of the same element after cleaning.

A solution of an oil-soluble emulsifier and kerosene was circulated through each unit for 8 hours. Circulation was by a 300-gpm centrifugal pump taking the solution from a 500-gal. overhead tank and returning it to the tank again after passing it through the cooler. Steam admitted to the water side of the cooler heated the solution to 130 F. To complete the cooling operation, coolers were thoroughly flushed with hot water and air. When the cleaned units were put back into service, oil entered the cooler at 129 F and left at 103 F. Before cleaning, oil temperatures were 155 and 150 F respectively.

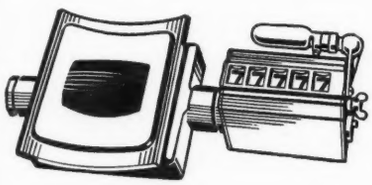
New York, N. Y. D A HEARN
Oakite Products, Inc





The COPES Type A-D Coal Counter

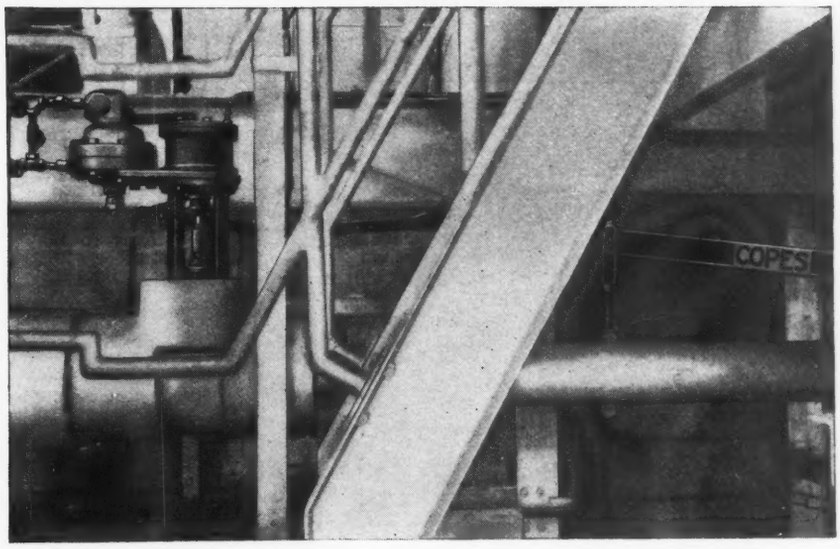
Helps build boiler efficiency. Gives an accurate, continuous reading of how much coal is fed to each stoker—indicating inefficient firing more quickly than any check of stoker revolutions or weigh larry reports. Inexpensive to buy, install and operate. Pays for itself quickly by making it easy to eliminate instantly operating inefficiencies. Saves time. The large illuminated dial is easily read at a distance of 30 feet.



Only one part—a soft rubber roller, highly resistant to abrasion—comes in contact with the coal. Measurement continues accurate for a longer time than if it depended on any wearing metal part in, or in contact with, the abrasive material. Nothing to stick, or break off, and cause "bridging" of coal in the pipe.

The COPES Counter can also be used to measure the quantity of other such granular material as cement clinker, crushed rock, limestone, grain or ore being moved through an inclined pipe.

Write for Bulletin 411



This Flowmatic Regulator

is holding boiler water level within ± ½ inch

Installed on a 425-pound pressure Babcock & Wilcox Integral Furnace Boiler in a well-known chemical plant (name on request), this COPES Flowmatic Regulator holds boiler water level within plus or minus ½ inch in regular daily operation. Such close level control means greater operating safety, and the accurate gearing of feed input to steam output means higher operating efficiency. If water level variation is excessive on your load swings, investigate the COPES Flowmatic. Write for Bulletin 409-B.

NORTHERN EQUIPMENT CO., 411 GROVE DRIVE, ERIE, PENNA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

Get closer level control with the

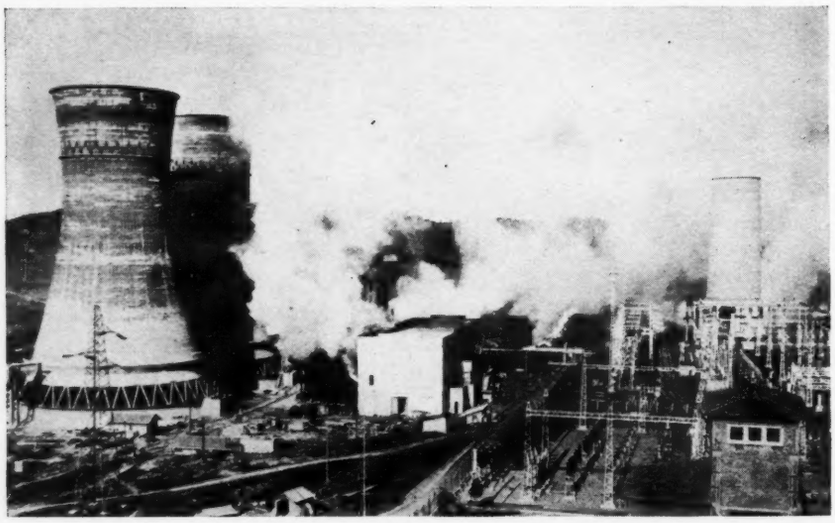
COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR

Engineers' Bookshelf



STEAM WITHOUT FUEL

Italy, land of no coal and no oil, traps earth's steam at Larderello. Four latest turbines add 12,500 kw capacity. Corrosive steam from wells generates power steam in heat exchangers. Condensing-water cooling towers at left—Wide World Photo

Electricity

ELECTRICAL YEAR BOOK (1939 edition). *Published by Emmott & Co, Ltd, 31 King St West, Manchester 3, England. 377 Pages, Pages, 4x6 in, many diagrams and tables, cloth binding. Price $.40.*

In the 1939 edition of this standard handbook on direct and alternating current, the section on ac systems has been rewritten to provide definitions in more familiar terms and to introduce more information of practical use to alternating-current users.

Some new material on exciters has been introduced into the section on turbine alternators and on single-phase induction motors in the section on induction motors. Revision of the section on electrical measuring instruments has been made to include treatment of the rectifier type. Some new matter is also included in the discussion of instrument transformers.

Refrigeration

HANDBOOK OF REFRIGERATING ENGINEERING (2nd Edition—1938). *By W R Woolrich, Dean of Engineering and Professor of Mechanical Engineering, University of Texas. Published by D Van Nostrand Co, Inc, 250 Fourth Ave, New York, N. Y. 425 pages, 4¼x7 in., numerous charts, tables, and illustrations, limp binding. Price $5.00.*

This second edition of a handbook published less than ten years ago was made necessary by rapid strides in application of refrigeration to an enormously widened field. The new edition adds extensive material on food preservation and quick freezing, to meet new trends.

The book retains the straightforward approach and the practicality of the previous edition. Starting with refrigeration definitions and basic data on food preservation, the author jumps right into a discussion of refrigerants in general, and ammonia in particular. Data on the selection and operation of refrigerating equipment follows, including compressors, condensers, and brine systems. Sections on thermodynamic and refrigerating equations are simply presented and should aid the practical engineer in wading through inevitable theory. The author then treats other phases of refrigeration, including electric-drive, absorption refrigeration, and refrigerants other than ammonia. Chapters on ice and ice-making will be welcomed by engineers in this field, and all refrigeration engineers will find material of value in the section on testing.

This book should be in the library of every power engineer responsible for selecting, designing, or operating refrigerating equipment, containing, as it does, a wealth of practical information. The only criticism possible, and it is a minor one, is apparent lack of any logical arrangement of chapters or sections.

Industrial Architecture

INDUSTRIAL ARCHITECTURE (1939). *By George Nelson. Published by Architectural Book Publishing Co, Inc, 112 West 46th Street, New York, N. Y. 176 pages, 9x12 in., 200 illustrations, diagrams, and floor plans, cloth bound. Price $6.*

This book is a compilation of descriptions, diagrams, illustrations, and plans of the work of Albert Kahn, Inc, showing new plants designed by the firm, including some of the largest in the United States. The book may be used by architect, engineer, industrialist and any whose work involves design, building, remodeling or operation of industrial plants.

Twenty-three pages are devoted to the power houses of Ford Motor Co, Chevrolet Motor Division, and Burroughs Adding Machine Co, each illustrated and described briefly. Many other illustrations of other plants built or remodeled by Albert Kahn, Inc, are shown. A detailed story of the history of industrial architecture is included, together with a history of the Kahn organization, showing departments and introducing various executive members of the firm.

Estimating

HOW TO ESTIMATE FOR THE BUILDING TRADES (1st Edition—1939). *By Gilbert Townsend, with Ross & MacDonald, Architects, Montreal, Canada, J Ralph Dalzell, Head, Architectural Engineering Department, James McKinney, Education Director, and Carl H Dunlap, Head, Electrical Engineering Department, American School. Published by American Technical Society, Drexel Ave and 58th St, Chicago, Ill. 629 pages, 5½x8½ in., 310 illustrations, 44 tables, 555 questions with answers, cloth binding. Price $4.50.*

Power engineers frequently are called upon to make estimates of work not directly connected with power generation. In this book he will find much that will be helpful to him in these projects, particularly in heating and ventilating, foundations, and walls, painting, hardware, sheetmetal plumbing, electrical work, and many other items involved in building construction.

Actual quantity survey and estimating methods are presented and explained by illustrative examples from plans and specifications of typical modern buildings. All calculations are given in detail so they can be readily understood. No attempt has been made to teach the mathematics of the building trade, but the chapter "Mathematics Related to Estimating," presents formulas and applications that will be found helpful.

BRIEF REVIEWS

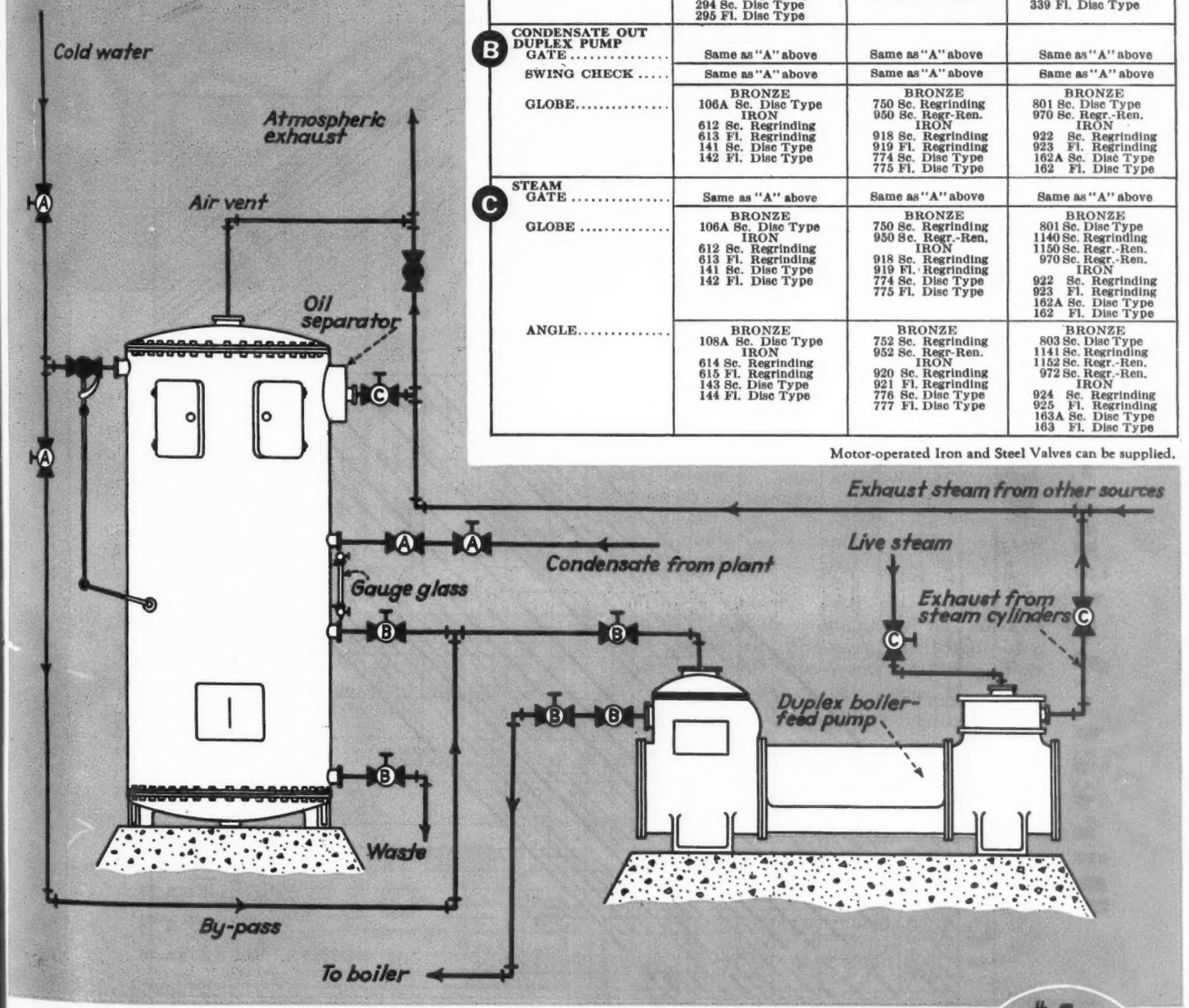
REPORT OF DETERMINATION OF MAXIMUM PERMISSIBLE CURRENT-CARRYING CAPACITY OF CODE INSULATED WIRES FOR BUILDING PURPOSES (1938). *Published by National Electrical Manufacturers Association, 155 East 44th St, New York, N. Y. Price 25 cents.*—Summarizes eight years of intensive research on the performance of heat-resistant grades of insulation.

MEASURING THE GROWTH AND SCALE RESISTANCE OF CAST IRON. (1938). *Published by Engineering Experiment Station, Ohio State University, Columbus, Ohio. Price 25 cents.*—Bulletin No. 100 describes development of a method for measuring growth in scale formation of cast iron and shows effects of varying composition on scale growth.

. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

STEAM AND WATER



REFERENCE CHART FOR JENKINS FIGURE NUMBERS

While Open Heater Connections, Condensate Connections, etc. are usual in the lower pressures, we have listed valves to include Extra Heavy.

		Standard	Medium	Extra Heavy
A	CONDENSATE FROM PLANT—COLD WATER			
	GATE	BRONZE 47 Sc. Travel.Spind. 370 Sc. Non-Rising IRON 650 Sc. O.S. & Y. 651 Fl. O.S. & Y. 325 Sc. Non-Rising 326 Fl. Non-Rising	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 277 Sc. O.S. & Y. 253 Fl. O.S. & Y. 251 Sc. Non-Rising 255 Fl. Non-Rising	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 204A Sc. O.S. & Y. 204 Fl. O.S. & Y 203A Sc. Non-Rising 203 Fl. Non-Rising
	SWING CHECK	BRONZE 352 Sc. Disc Type IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type
B	CONDENSATE OUT DUPLEX PUMP			
	GATE	Same as "A" above	Same as "A" above	Same as "A" above
	SWING CHECK	Same as "A" above	Same as "A" above	Same as "A" above
	GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr-Ren. IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 970 Sc. Regr.-Ren. IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
C	STEAM			
	GATE	Same as "A" above	Same as "A" above	Same as "A" above
	GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Ren. IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Ren. 970 Sc. Regr.-Ren. IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
	ANGLE	BRONZE 108A Sc. Disc Type IRON 614 Sc. Regrinding 615 Fl. Regrinding 143 Sc. Disc Type 144 Fl. Disc Type	BRONZE 752 Sc. Regrinding 952 Sc. Regr-Ren. IRON 920 Sc. Regrinding 921 Fl. Regrinding 776 Sc. Disc Type 777 Fl. Disc Type	BRONZE 803 Sc. Disc Type 1141 Sc. Regrinding 1152 Sc. Regr.-Ren. 972 Sc. Regr.-Ren. IRON 924 Sc. Regrinding 925 Fl. Regrinding 163A Sc. Disc Type 163 Fl. Disc Type

Motor-operated Iron and Steel Valves can be supplied.

JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.

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1864—1939 DIAMOND ANNIVERSARY

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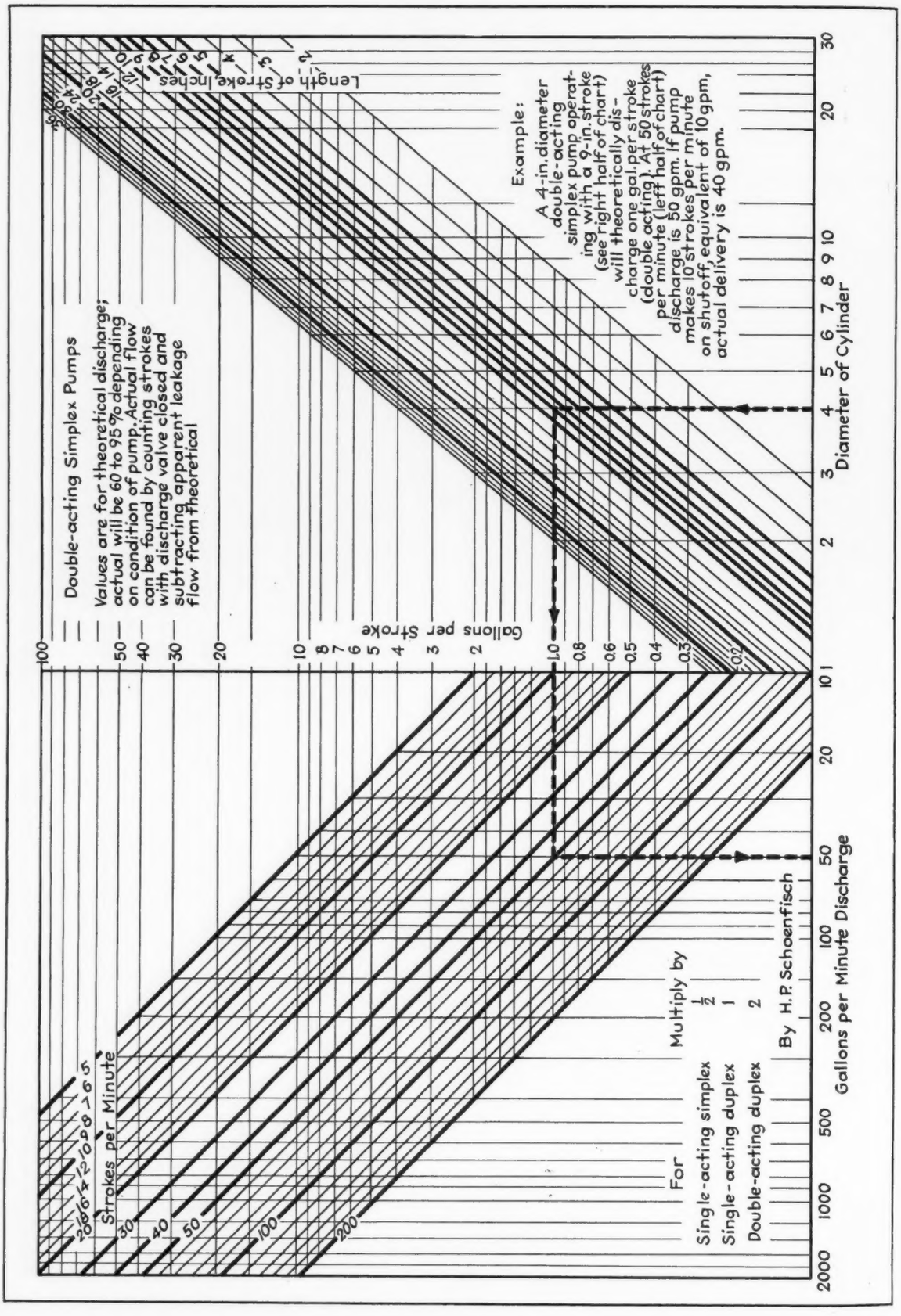
Number 81

Direct-Acting-Pump Capacity Chart


Double-acting Simplex Pumps
Values are for theoretical discharge; actual will be 60 to 95% depending on condition of pump. Actual flow can be found by counting strokes with discharge valve closed and subtracting apparent leakage flow from theoretical
Length of Stroke, Inches
Strokes per Minute
Gallons per Stroke
Diameter of Cylinder
Gallons per Minute Discharge
Example:
A 4-in. diameter double-acting simplex pump operating with a 9-in. stroke (see right half of chart) will theoretically discharge one gal. per stroke (double acting). At 50 strokes per minute (left half of chart) discharge is 50 gpm. If pump makes 10 strokes per minute on shutoff, equivalent of 10 gpm, actual delivery is 40 gpm.
For
Single-acting simplex
Single-acting duplex
Double-acting duplex
Multiply by
1/2
1
2
By H.P. Schoenfisch

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Let us "AUDIT" Your Water Conditions

You audit your books—why not your water conditions.

Such an audit offers protection for your steam equipment from the ravages caused by deposits of incrusting solids, corrosion, caustic embrittlement, steam entrainment and other commonly experienced difficulties that shorten the life of equipment and increase operating and maintenance costs.

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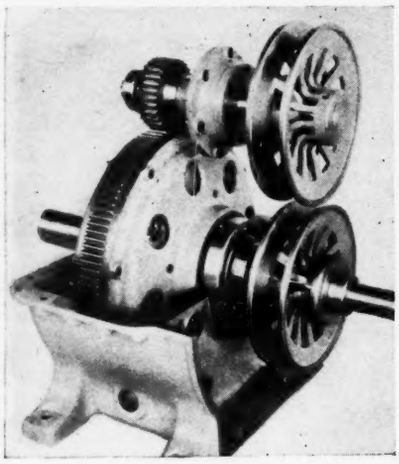
What's New in Plant Equipment

Variable-Speed Transmission

"VARIDUCER" is an infinitely variable-speed-reduction transmission in which is incorporated principles of planetary-gear transmission for speed reduction and differential-gear principle for adjustable speed control. Sun gear of the planetary system is on input shaft, and planet gears are connected to output shaft as in conventional planetary reduction gear. Around the planet gears is a ring gear that meshes with the planet gears on the inside and on the outside with a pinion on a jack shaft. The ring gear, supported in a casing on two bearings, can be rotated. Other end of the jack shaft connects by a V-belt to the main shaft. Both V-sheaves are fixed to their shafts but their pitch diameter



can be adjusted to vary the speed of the jack shaft and therefore that of the ring gear.

In this unit, if the V-belt were removed and the ring gear held, then the unit would operate as a conventional planetary gear, with output speed depending on the gear ratio. By driving the ring gear in an opposite direction to the planet gears the output shaft will slow down and if the ring gear is rotated in the same direction as the planet gears, output shaft speed will increase. In other words, changing ring-gear speed changes output speed. Adjusting pitch diameter of the V-sheaves changes the speed of the ring gear and that of the output shaft.

B F Perkins & Son, Inc, Holyoke, Mass.

Charge Control Unit

MODEL ES battery-charge control is designed for use with any of the following charging systems: either bulb or dry disk types of rectifiers, dc generators, or dc bus with charging resistors. Charge control is contained in a metal cabinet, $11\frac{1}{8}$ x $10\frac{7}{16}$ x $4\frac{1}{2}$ in. with hinged door. Within the cabinet, small self-starting synchronous motor-driven interval-time switch, operating from a 60-cycle ac supply, starts the charge or increases it once every hour

by resetting a temperature-compensated relay, which, in turn, operates an auxiliary. As soon as battery voltage rises to the relay-operating voltage, contacts of the latter open, de-energizing the auxiliary relay, which then opens its contacts to stop the charge. A continuous-charge toggle switch is provided in case it is desired to discontinue automatic charging temporarily.

The Electric Storage Battery Co, Philadelphia, Pa.

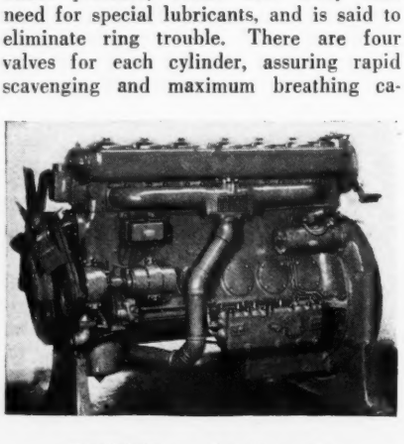
Liquid Soldering Flux

"SPECIAL X" liquid soldering flux can be used on brass, copper, cadmium, stainless steels, zinc, monel, iron, and many other alloys. Lowered surface tension and good wetting power of flux cause quick and uniform flow into all cracks and crevices, and research has shown that it is especially good in the production of line soldering of expansion valves, electrical controls, small pressure tanks, etc.

Industrial Service Laboratories, 915 W Oklahoma Ave, Milwaukee, Wis.

200-Hp Diesel

MODEL ME-650 engine conforms to standard model ME. Injection is direct into a plain symmetrical combustion chamber and injector and fuel pump are combined into one unit which can be easily removed and reinstalled. Pistons are oil cooled under pressure, which does away with need for special lubricants, and is said to eliminate ring trouble. There are four valves for each cylinder, assuring rapid scavenging and maximum breathing ca-

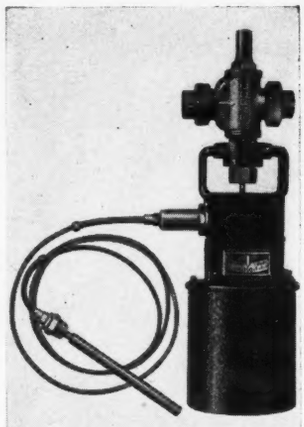


pacity. The engine is automatically shut off should oil pressure drop below a certain pressure while control is through a single lever which permits easy and simple toggling-in for remote control. The engine is started by a standard 24-volt starter, and can be had either as a bare engine or with radiator and full enclosure. Skids, outboard bearings, and direct-connected generator units are also available.

Murphy Diesel Co, Ltd, Milwaukee, Wis.

Self-Contained Temperature Regulator

TYPE SE temperature regulator combines simplicity and compactness of self-operated regulator with sensivity and accuracy of electric control. For any temperature between —40 F and +650 F. Each regulator is calibrated at the factory for any desired temperature and is then adjustable in the field 50 deg higher and lower than factory calibration. Operation is by single phase ac current, 110 or 220 volts. Current consumption is less than 50 watts and no relays are required. The valve is a throttling



type and adjusts itself automatically to any position between wide open and closed. Sensitivity of the regulator is adjustable in use, assuring balanced control without hunting. Standard valves, ½- to 2-in. inclusive, have bronze bodies, stainless steel trimmed and union connections. Valves 2½- to 4-in. are iron body, bronze trimmed. Sizes 2½ to 3½ in. are furnished screwed, 4-in. flanges, flanges drilled to ASME standards.

Sarco Co, Inc, 183 Madison Ave, New York, N. Y.

Flexible Hose

IMPROVED air hose uses synthetic rubber in tube or lining. This is said to give protection against deterioration of the lining in handling hot oil. Cord principle of construction, similar to that used in the manufacture of tires, is continued, but an improved method of bonding the cord carcass to the tube results in a greater

HOW TO GET MORE GALLONS AT LESS COST!

Here's a Tip on How to Cut Your Pumping Costs! And It's Based on Facts ... Facts You Should Know About Extra Value SSUnit Pumps!

There's more than one way to save money . . . but there's no quicker way than to replace those old, worn out pumps in your plant with modern Allis-Chalmers SSUnit Pumps!

For great engineering — the same great engineering that designed and built the gigantic Boulder Dam and Niagara Falls turbines — originated the low-cost, motor coupled pump in 1926 to give industry greater pumping economy.

And that pump—the fast-selling SSUnit—is setting new low-cost pumping records . . . actually giving plants all over the country more water per dollar of power cost!

There's new flexibility of operation in SSUnit's compact, husky design that cuts maintenance costs . . . beats space waste . . . lets you put the unit in any position you want it!

Bronze construction of the enclosed runner, wearing rings and shaft sleeves means complete protection against rust or excessive wear. And every unit is completely tested before delivery . . . your guarantee that it can go to work for you the minute it is installed.

Get Undivided Responsibility!

Remember, too, that coupled to the pump is the famous Allis-Chalmers Lo-Maintenance Motor . . . the motor that has proven performance records of beating conditions that many times wreck ordinary motors in a few weeks. There's no "buck-passing" . . . Allis-Chalmers accepts full responsibility for both the motor and the pump!

These are plus features that work for you . . . give you a pump that cuts dollars from your operating costs! Call the nearest district office, or write direct to Allis-Chalmers, Milwaukee. Get started today on real pump savings!

1072

MAINTAINING PROPERLY HUMIDIFIED air for the air-conditioning system of a large mid-western malting plant, this Allis-Chalmers SSUnit pump and Lo-Maintenance Motor cut service costs to a minimum.

CENTRIFUGAL PUMP DIVISION

ALLIS-CHALMERS

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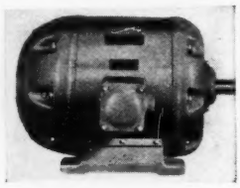
SINGLE-STAGE DOUBLE-SUCTION PUMPS • CLOSE-COUPLED SINGLE-STAGE SSUnit PUMPS • MULTI-STAGE PUMPS • PAPER STOCK PUMPS • MIXED FLOW AND AXIAL FLOW PUMPS • AND SPECIAL DESIGNS FOR UNUSUAL APPLICATIONS

degree of adhesion. Redesigned hose is claimed to have greater ability to resist internal pressure as well as external punishment, resist the effects of hot oil, be easier to handle because of increased flexibility and because of smaller outside hose diameter.

New York Belting & Packing Co, 1 Market St, Passaic, New Jersey.

Explosion-Proof Motors

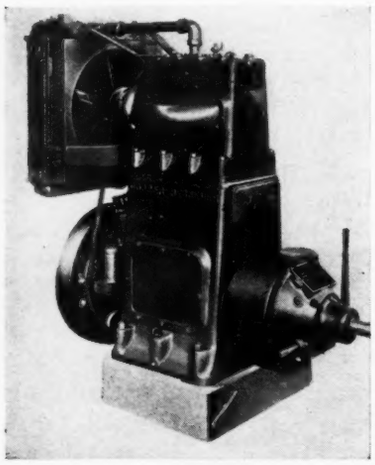
NEW-LINE of fan-cooled, explosion-proof ac or dc electric motors is of solid cast iron construction, with reinforced end bells, extra large conduit box, cartridge-type bearings, easily removable fan guard and air grille, extra heavy steel cover, ribbed housing construction, and patented bearing guard. Motors are designed for use in all Class 1, Group D explosive atmospheres, or where gasoline, lacquer, solvents and similar volatile liquids are made, stored, used, or handled. They are built to NEMA Standards and are interchangeable with



corresponding NEMA frame sizes of other types of motors, both ac and dc. Motors can be operated with equal efficiency either horizontally or vertically, and are available in a wide variety of both mechanical and electrical characteristics.

The Louis Allis Co, Milwaukee, Wis.

Vertical Gas Pumping Engine



TYPE G-SC engine is rated 25 to 35 hp at speeds from 600 to 800 rpm. Is a 2-cylinder, 2-cycle unit with bore of 5½ in. and stroke of 7 in. Overall height is 4 ft 1¾ in., width 2 ft 6 in. and length with clutch 5 ft. It is started by hand or compressed air, and Meehanite metal is used for cast parts of the engine.

Cooper-Bessemer Corp, Mt Vernon, Ohio.

Gear-Chain Hoist

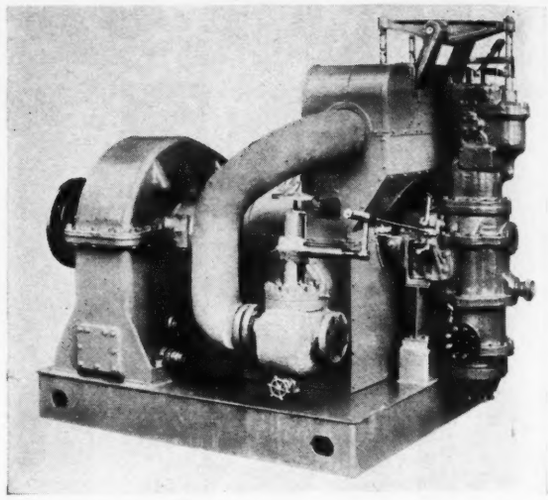
"POWER MASTER" gear-chain hoist has controlled gravity loading by clutch and governors. Load may be stopped at the fractional part of an inch. Other features include lubri-sealed ball bearings, with planetary gear system sealed and running in oil. Is built with capacities ranging from 1 to 8 tons, with unit weights as low as 86 lb for the 1-ton and 169 lb for the 8-ton.

Coffing Hoist Co, Danville, Ill.

High-Speed Engine Pressure Indicator

FOR use in mapping diagrams of high-speed internal-combustion engines, the indicator is of balanced diaphragm type. The indicator can be used at speeds up to 3000 rpm and for pressures from 10 lb sq in. below atmospheric to 1500 lb sq in. above, and its accuracy is approximately that of a standard 6-in. Bourdon-tube dial gage. The indicator outfit consists of three parts: pressure-balancing instrument which is screwed into the opening in the engine cylinder as a spark plug; timing element, which is secured to a revolving part of the engine; and the coordinating, measuring, and recording apparatus located at any convenient place and connected to the indicator and timer with wires and flexible pressure tubes.

American Instrument Co, Silver Spring, Md.



Steam Turbine

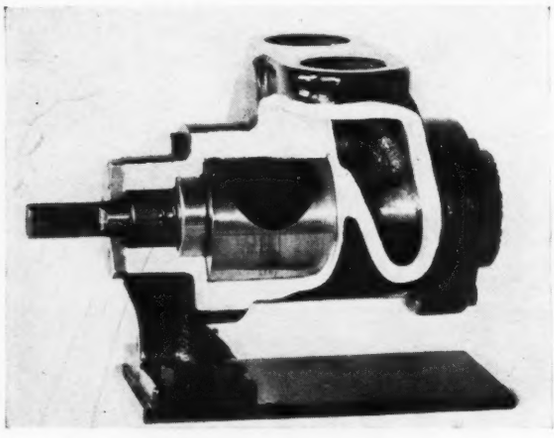
TYPE M improved multi-stage steam turbines, ranging from 100 to 2000 hp, 100 to 5500 rpm, are for driving pumps, fans, compressors, pulverizers and other machinery. Made for condensing-extraction, non-condensing, non-condensing extraction, or mixed-pressure service. Turbine can be supplied for pressures to 650 lb, temperature to 750 F, exhaust pressures to 200 lb, vacuum to 29 in. and extraction pressures to 200 lb.

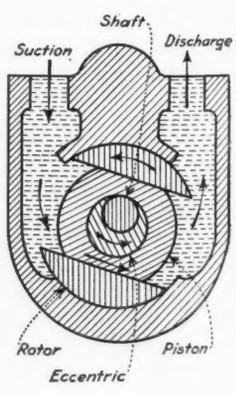
Westinghouse Electric & Mfg Co, E Pittsburgh, Pa.

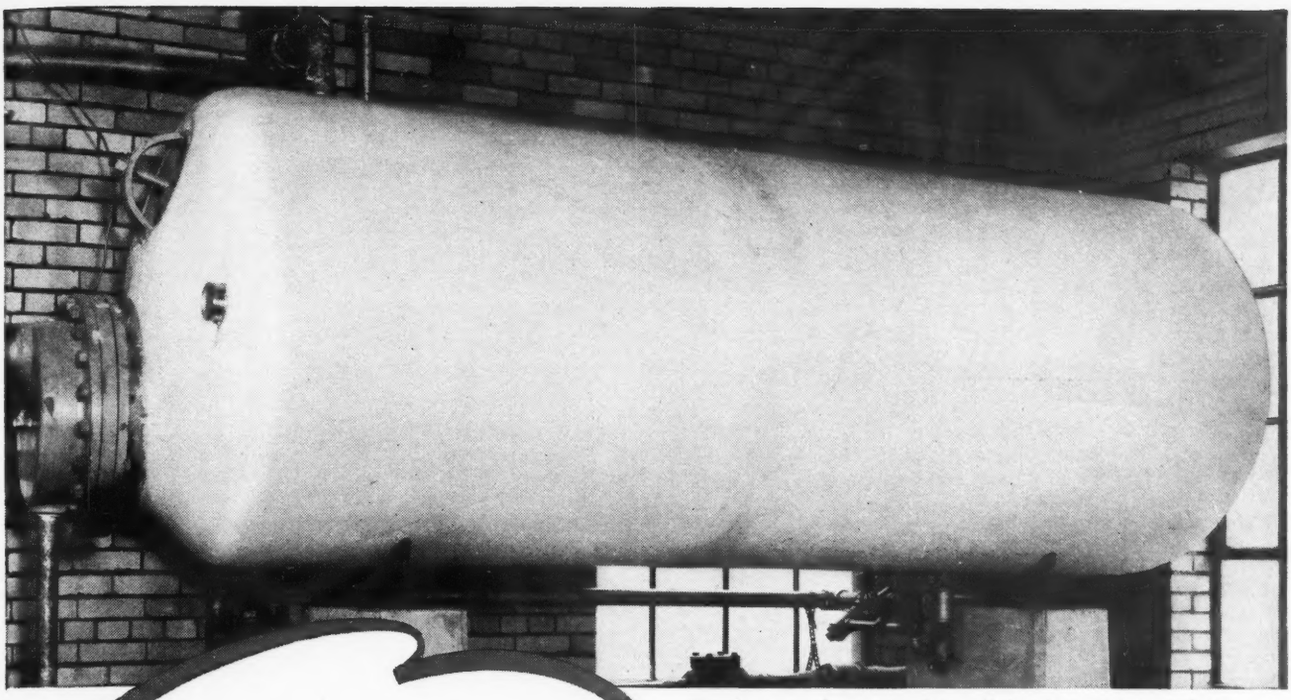
Rotary Pump *(Shown below)*

"ROTAPISTON" rotary pump comprises two reciprocating pistons at right angles to each other, in two rotating cylinders (see photo). Each piston is double acting to give continuous flow. Pistons are mounted on an eccentric so that when the shaft rotates the pistons are moved back and forth in cylinders as the whole rotor revolves. Design of this combination is such that the rotor and pistons operate at one-half the speed of the eccentric shaft, a positive mechanical 2:1 movement without gears. Eccentric shaft is carried in ball bearings and drive end is provided with a packless seal. Adapted for operation at speeds of from 100 to 1800 rpm and available in sizes of 0.5, 1 and 2 gpm per 100 rpm.

Globe Products Co, Cleveland, Ohio.





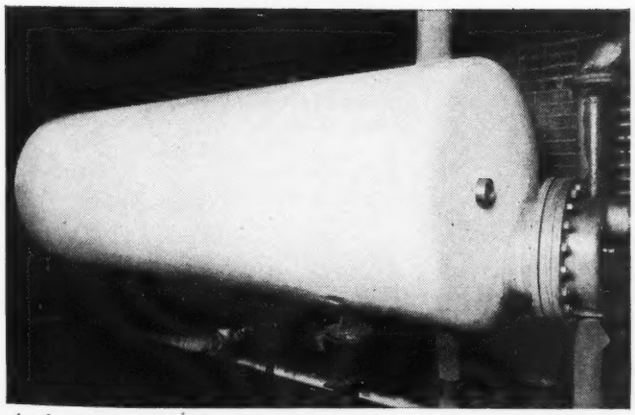


Everdur storage heater recently installed in the City Hospital of Akron, Ohio. Made by THE SIMS COMPANY, INC., Erie, Pa.,—dimensions 48"x144", capacity 3500 g.p.h. It serves the hospital laundry.

City Hospital of Akron, Ohio

replaces rustable heaters with

Everdur



Another SIMS Everdur heater installed in this hospital—42"x144", capacity 2000 g.p.h. It is used for general hospital service.

HOSPITALS need an abundance of hot water . . . water without a trace of rust. Besides, limited operating budgets make it desirable to have heating equipment that gives complete freedom from periodic rust repairs. That's why so many hospitals select storage heaters with shells of non-rust Everdur Metal. The City Hospital of Akron, Ohio, is a typical example.

In Commerce, Industry and Homes

All over the country—in schools, department stores, office buildings, textile mills, laundries and various institutions—rustable heaters are being replaced by strong, long-lived heaters made of Everdur Metal. Here are the facts: Nowadays more Everdur tanks and heaters are sold in a week than were built in the entire year 1929.

Everdur—Anaconda's copper-silicon alloy—is rustless, exceptionally strong, welds readily and is moderate in cost. Metals with such a combination of extraordinary qualities are rare indeed. For non-rust tanks and heaters of all types, consult the leading equipment manufacturers. Remember the name—*Everdur Metal.* 8950

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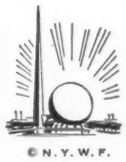

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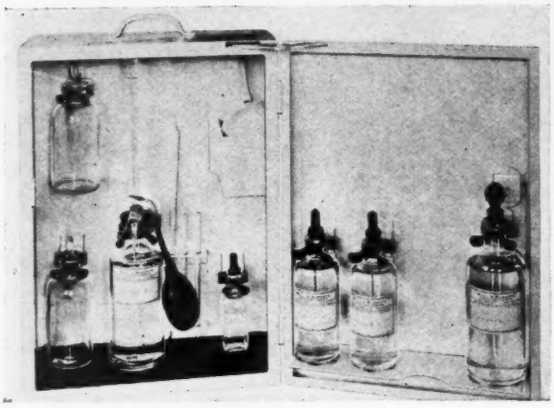
"EVERDUR" is a trade-mark of The American Brass Company, registered in the United States Patent Office.



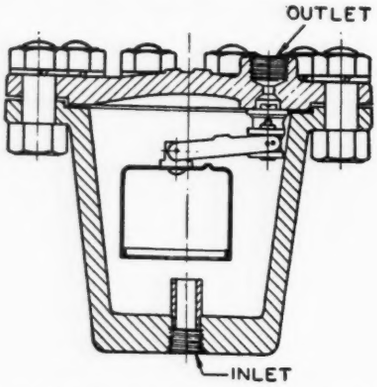
Oxygen Tester

TESTING CABINET determines quantities, if any, of oxygen which may be found in boiler feedwater. Is of welded-steel construction, with baked enamel finish, and all apparatus clips are of stainless steel. The reagent pipettes, or liquid-transfer tubes, have bulbs which automatically measure desired quantity of test solution. An automatic self-leveling burette, or measuring tube, is used in the final drop-by-drop measurement. To gather the sample to be tested, special sampling bottles minimize danger of trapping air at completion of the sampling operation. The bottles are supplied with Neoprene stoppers to avoid negative interference which arises from use of vulcanized rubber stoppers. Cabinet measures 17 x 13 x 7½ in. and all apparatus is protected against breakage.

Bull & Roberts, 117 Liberty St, New York, N. Y.

Inverted-Bucket Steam Trap

BS TYPE inverted bucket trap is now made for pressures up to 900 lb per sq in. and is suitable for superheated steam of any commercial temperature. Body and cover of the trap are of high-grade steel forgings of a shape to give maximum strength. Special alloy steel bolts attach cover to



body. All interior parts, including bucket, are stainless steel. Hardened stainless alloy is used for the renewable valve seat and disk. When using saturated steam at 250 lb or lower, bucket and mechanism can be supplied in brass with reduction in cost.

Sarco Co, Inc, 183 Madison Ave, New York, N. Y.

Screw Thread System

"AERO-THREAD" screw thread system uses spirally wound insert or bushing of precision formed, high-tensile bronze spring wire. This insert fits into a tapped hole by screwing threads and design of the insert is such that when it is screwed into place, it becomes part of the tapped hole. Can also be removed and replaced if necessary.

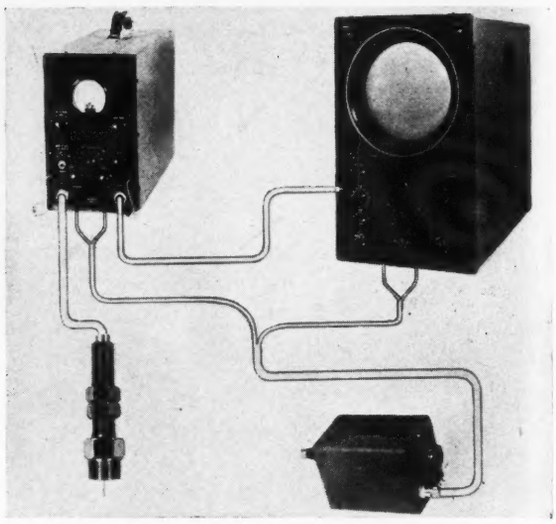
Air Associates Inc, Roosevelt Field, Long Island, N. Y.

Circuit Breaker

TYPE ET Circuit breaker uses standard 600-amp frame size and incorporates a 20,000 amp interrupting capacity. This type, applicable on power panels, panelboards, load centers, switchboards and individual mountings, ranges in size from 10-amp, 5,000 volts interrupting capacity to largest described. Trip units are interchangeable,

are calibrated and contained in case which is sealed to prevent tampering. Instantaneous trip features are calibrated at six to eight times the ratings of the circuit breaker. Handles are dark red bakelite to distinguish from standard 600-amp frame circuit breaker.

I-T-E Circuit Breaker Co, Philadelphia, Pa.



Electrically Operated Engine Indicator

DEVELOPED for designers and manufacturers of high-speed internal-combustion engines, this unit accurately measures rapidly changing cylinder pressures. Consists of a pressure unit, a cathode ray oscillograph, an amplifier, and a synchronizer unit. The pressure unit converts rapidly changing pressures into electrical impulses which are amplified and pictured on the screen of a cathode ray tube. This is done by transmitting these pressures to quartz crystals which, through their "piezo-electric" properties, generate on their surfaces electrical charges directly proportional to the pressures applied to them. Unit is unaffected by temperatures up to 350 C and is built to withstand pressures up to 5000 lb per sq in. The two quartz crystals are mounted in a stainless-steel holder designed for insertion into a threaded hole in the cylinder head. A piston at the lower end of the holder receives pressures within the cylinder and transmits them directly to the crystals. Diaphragm holds the piston in place and at the same time permits it to transmit pressure variations to the crystals. Accuracy of the unit is high at engine speeds of over 1000 rpm on 4-cycle engines. The unit is not recommended for slower speeds.

RCA Manufacturing Co, Camden, N. J.

Heavy-Duty Field Rheostats

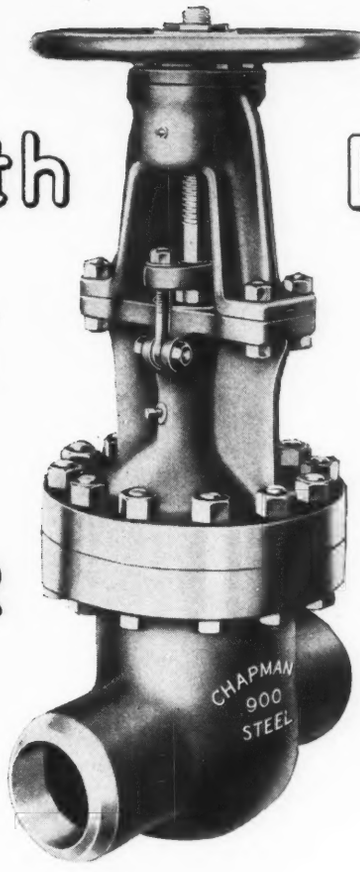
TYPE JM mill-type field rheostat consists of a faceplate with contact arm and tube resistors assembled as a unit in a frame. The faceplate provides 60-point speed control. Vitreous-enamel-protected "Ribflex" and "Vitrohm" resistor tubes are assembled in a frame of insulated tie rods attached to the faceplate. Tubes may be removed and replaced either to repair or change the characteristics of the rheostat. Unit is mounted in sheet-steel enclosure with four bolts so that entire assembly may be removed without disturbing conduit or wiring. Enclosing box has perforations for

(*Continued on page 126*)

"The Fourth Dimension"

of any

POWER HOOKUP



Chapman Steel Valves

It's a swell idea to analyse power "hookups" in terms of *three dimensions*. But how about that less tangible *fourth* dimension — flow control?

The best hookup in powerdom will not function at top efficiency unless every valve in the hookup is "tops". Chapman Power Plant Valves supply the perfect answer to this fourth dimension problem. For modern high pressure, high temperature steam, Chapman Steel Valves add the Q. E. D. to the toughest service problem.

The Chapman standard lines of steel valves embrace a full range of types and sizes, for pressures up to 2500 pounds, and temperatures to 1000 degrees Farenheit.

These valves are built to rigid standards both as to materials and workmanship. All castings are made in Chapman's own foundries under direct metallurgical control, and of metals which long experience and exhaustive research have proved best adapted for the service intended. Chapman steels include Chromium, Nickel, Tungsten and Molybdenum Alloys to meet all accepted specifications.

THE CHAPMAN VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASS.

Spring Song . . .

Say, Ma, you know it's gettin' awful hot?
Jest playin' one ole cat I sweat a lot!
A frog wuz croakin' in the pond last night,
The poplar buds is gettin' mighty tight.
The pie plant's up a half a foot, I know,
The purple flags were green a week ago.
There's signs of spring around most everywheres!
I wisht 'at I could change my unawears!
Ma, kin I?

They's itchin' me to beat the very band;
Say, Ma, it's gettin' more'n I kin stand!
The wax-wings wuz aflyin' north today,
I heard a robin scoldin' at a jay,
The seedin's sproutin' in the stubble field
And Pa is wonderin' will the clover yield.
It's spring, you see; why look most anywheres!
I wisht 'at I could change my unawears!
Ma, kin I?

They sticks an' scratches me like all gitout;
I'm agoin' bugs, there ain't a bit a doubt!
I seen a crocus peekin' through the ground,
I think a honey-bee wus stirrin' 'round.
The sap is risin' in the sugar trees,
I smelt a whiff of willow on the breeze.
It's spring, I tell you, Ma, just everywheres—
I wisht 'at I could change my unawears!
Ma, kin I?

—P D Cog, *Chicago Tribune*, April 16, 1924

Doesn't that one take you back to the Springs of long ago, when first chance you got, you wiggled bare toes in the dirt, and tried swimmin' in the crick the first time Ma wasn't lookin'?

Remember, too, how Spring used to give you, as well as the trees, the plants, and the animals, a brand-new feeling of pep, a sort of "gladness" about being alive? Spring is the time when you planned all those mighty pirate hunts, those secret dens, those other projects which would make you a second Jesse James or Buffalo Bill.

Spring, much more than New Year's, is the time of new determination and of great resolves. You feel it each year, just as I do. It's the time when you sluff off the clothes and the outmoded ideas of winter. It's the end of the heating season, the time to begin cleaning up, pepping up, improving efficiency, both of yourself and of your plant.

It's the time to do things—don't you feel it?

George Edwards

Engineer

SAFE STOPS feather Soft

STOP! A crane-load of steel shapes. A hoist car crowded with men. The huge gate locks which hold a surging river. These plunging forces are controlled by a giant hand, brought to a safe, *cushioned* stop—by magnetic brakes perfected by Cutler-Hammer.

In Milwaukee, Cutler-Hammer engineers tested many compositions under severest service conditions to find a satisfactory brake-wheel material. On the basis of both cost and performance cast Nickel-manganese steel was selected. For added toughness, strength and wear resistance, this Nickel alloy steel is oil hardened to a Brinell hardness of 352-429.

New, unique ball jack in C-H brake is of high Nickel-Molybdenum steel. You can depend on alloys reinforced with Nickel to hold the load—and to hold down yearly costs. Please write for information.

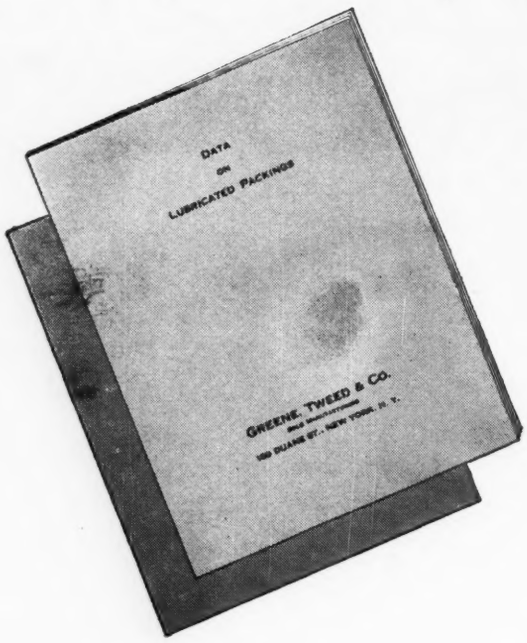
(ABOVE) *Cutler-Hammer magnetic brake, type TM, AC torque motor operated. Friction bands are forced against a cast Nickel alloy steel brake-wheel for cushioned stops.*

NICKEL ALLOY STEELS

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

"PALMETTO"
REG. U.S. PAT. OFFICE
THE ALL-SERVICE
PACKING

JUST OFF THE PRESS!



SEND FOR YOUR COPY

GREENE, TWEED & CO.
109 Duane Street, New York, N. Y.

Please send me free of charge your new booklet, "Data on Lubricated Packings".

Name _____

Address _____

Name of Firm _____

Steam—Buy the Standard Pound

(Continued from page 85)

Its value is equal to $\frac{\text{Btu/kwhr}}{\text{Btu/lb std steam}}$. Its value per kwhr in the case just illustrated is $\frac{3412.75 \text{ Btu/kwhr}}{1155 \text{ Btu/lb std steam}}$ or 2.955 lb standard steam/kwhr. The thermal efficiency of any of the prime movers, then, becomes $\frac{2.955}{\text{lbs std steam/kwhr}}$

For boiler-efficiency calculations, standard steam equivalent of fuel heat is direct and convenient. For solid fuel purchased by the ton, the following relationship is convenient:

Thousand lb of std steam equiv. ÷ ton of fuel =

$$\frac{\text{2000 lb/ton x Btu/lb as fired}}{\text{1000 x 1155 Btu/lb std steam}}$$

= .00173 x Btu/lb as fired.

Boiler eff. =

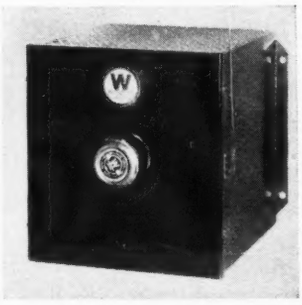
$$\frac{\text{Thousand lb std steam evaporated}}{\text{.00173 x Btu/lb fuel as fired x ton fuel}}$$

Having established the conditions and heat value for a standard steam and revised charts and constants for easy calculation, it can readily be seen how such a system can simplify calculations and the relation between accounting records and station log.

All steam to electrical generation, process, heating, station auxiliary, etc, can be readily handled on this standard basis. Fuel costs are accurately distributed. For the operators, comparisons are readily available for overall efficiencies, and the combination of machines for best economy readily determined for any load condition.

New Equipment

(Continued from page 122)



maximum ventilation, and contains a knockout for a ¾- or 1-in. conduit in the bottom near the back. Front cover is removable. A 3½-in. composition hand wheel is mounted on rheostat shaft, and for remote control a 5-in. sprocket wheel is available.

Westinghouse Electric & Mfg Co, Pittsburgh, Pa.

Synchronized Pump Control

SYNCHRONIZED unloading and loading device has been developed for automatic delivery control of high-pressure reciprocating

WHO'S AFRAID of the BIG BAD SHORT CIRCUITS NOW?

IT'S a G-E AIR BREAKER WITH PLENTY OF "IC"

"I C" = Interrupting Capacity

G-E AIR CIRCUIT BREAKERS have the necessary interrupting capacity to protect your men and equipment. The famous "arc quencher" breaks up the most threatening arcs into countless small bits.

These breakers do more than protect. They minimize production delays. Service can be restored immediately by the turn of a handle. There are no parts to be replaced.

They also provide three-phase interruption.

Wise operators are installing them on all branch circuits where the adequacy of the "I C" is under suspicion. For main circuits, General Electric offers its popular factory-assembled, metal-enclosed switchboard with draw-out-type air breakers.

If you have any question about how to determine the interrupting capacity needed, in order to know the size of circuit breaker to use, get in touch with the nearest G-E office.

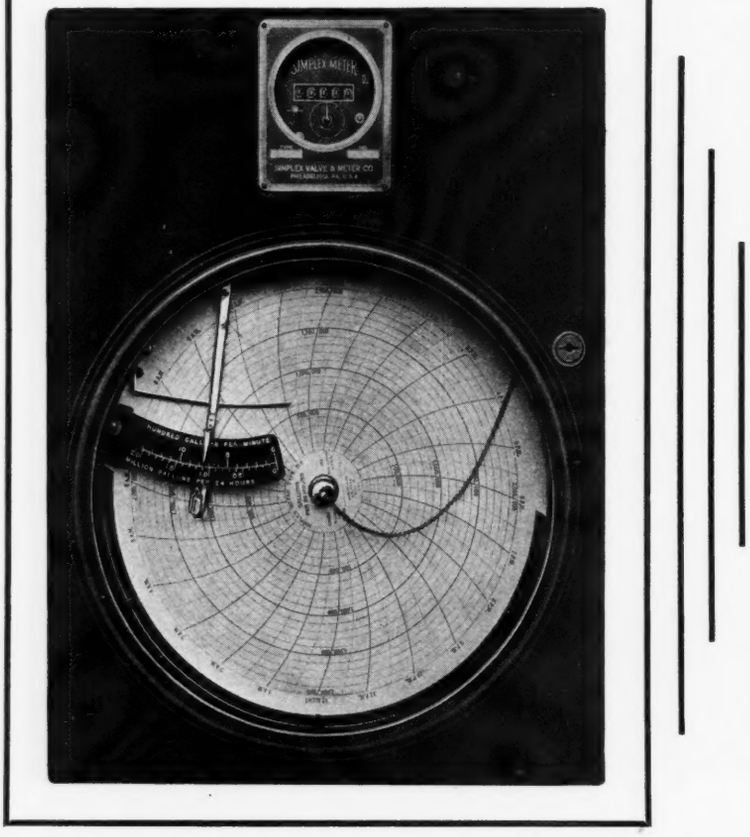
THE severity of a short circuit depends largely on the capacity of the transformers that feed the circuits, and it can *not* be determined by the normal load on the circuit. As plant loads have grown, transformer capacities have been materially increased. Therefore, short circuits present an ever-increasing hazard. They gravely endanger personnel and property wherever the power supply has outgrown the interrupting capacity ("IC") of the protective devices. Are you sure of your "I C"? With G-E air circuit breakers of *known* interrupting capacity, you *can* be sure.

G-E AIR CIRCUIT BREAKERS ARE AVAILABLE WITH INTERRUPTING RATINGS UP TO 80,000 AMPERES

GENERAL ELECTRIC

890-81

SIMPLEX METERS



THE ALL-PURPOSE TYPE MS

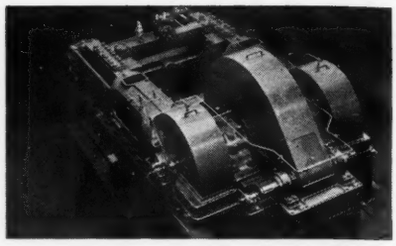
A compact, flexible instrument, actuated by the Simplex Bell-Shaped float. Available as an indicator, a Recorder, a Totalizer, or with any combination of these scales. Measures any type of fluid. Calibrated for gallons per day, gallons per minute, pounds per hour, or other units as desired.

Our thirty years of specialized experience and constant mechanical improvements have brought to the engineering world an infallible instrument for the measurement of WATER, BOILER FEED, AIR, GAS, SEWAGE, CONDENSATE, EVAPORATE, STEAM, PROCESS LIQUORS, CORROSIVE FLUIDS, ETC.

●

Interesting Bulletins on the operating principle and advantages of the Simplex method will gladly be sent to you upon request.

SIMPLEX VALVE & METER CO.
68th & UPLAND STS. PHILADELPHIA, PA.
OFFICES IN PRINCIPAL CITIES

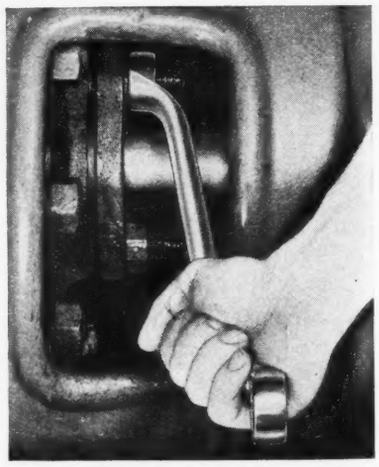


pumps. Suction-valve controlled, air actuated, the new mechanism guarantees a quick but gradual decelerating fluid delivery from full flow to zero, and vice versa. In either case, action is the same and time required for fully loading or unloading any type of multiple plunger reciprocating pump, horizontal or vertical, duplex, triplex, or otherwise, does not exceed one-half of one pump revolution. Power losses are minimized when the pump is unloaded, and there is no loss of pressure water in the operation.

Worthington Pump & Machinery Corp, Harrison, N. J.

Double-Offset Wrenches

"BOXOCKET" wrenches have two different wrench openings, and all sizes from $\frac{7}{16}$- to $1\frac{5}{8}$-in. are included within range of this series. Wrench head grips the nut on all sides and distributes the pulling strain evenly. Can be used over long threaded bolts on which socket wrenches cannot be used, or in small clearance



spaces above the bolts, double broaching of head permits use in close places where handle movement is limited. The offset head allows the wrench to be used over obstructions, also providing clearance space for the user's finger, and long handles provide leverage for loosening tough nuts or for pulling them up tight.

Snap-on-Tools Corp, Kenosha, Wis.

Gas Scrubber

IN THE "PEABODY" triple-action scrubber, gas enters near scrubber base and is relieved of coarse particles by cyclonic action. The gas passes upward through a zone of water or scrubbing liquid, supplied by slowly rotating sprays, operating at only 10 to 15 lb pressure. Dust particles mingle with water droplets at this stage.

ATTENTION, ALL BELT USERS!

Only ONE cord belt has this patented BALANCED construction that insures a true-running belt

BALANCED BODY made of heavy rope-cord spiralled continuously without a splice. Cord on opposing sides of belt axis is twisted in opposite directions to neutralize torque of cord.
BALANCED COVER laid parallel to axis of belt — made of fabric in which alternate warp threads are twisted in opposite directions to prevent side-creep.
RIGHT-HAND TWIST
LEFT-HAND TWIST
GOODYEAR COMPASS CORD BELT
balanced construction fully covered by U. S. and foreign patents

THE truly sensational success of the Goodyear COMPASS Cord transmission belt in solving industry's most difficult belting problems has led to many imitations seeking to capitalize on the magic word "cord."

But what makes the Goodyear COMPASS the truest-running, most nearly stretchless belt on the market—what gives it such exceptionally high flex-life and long wear—is a fully patented method of cord construction no other belt manufacturer can employ!

The Goodyear COMPASS Cord is a modernized flat belt version of the ancient rope drive. With rope drives, as you know, it is necessary to use grooved pulleys to keep the ropes from running off due to their torque or twisting action.

In the COMPASS this torque is balanced by twisting the ropes, or cords, on opposing sides of the belt axis in opposite directions. Alternate warp threads in the fabric cover are similarly twisted. This patented construction in both body and cover neutralizes any tendency to run off the pulley with an equal pull toward the opposite side, insuring a belt that runs true.

More than this, it permits Goodyear to use larger, stronger cord, eliminating fabric plies entirely in the carcass, and making a thinner, stronger belt with far higher flex-life and longer service-life.

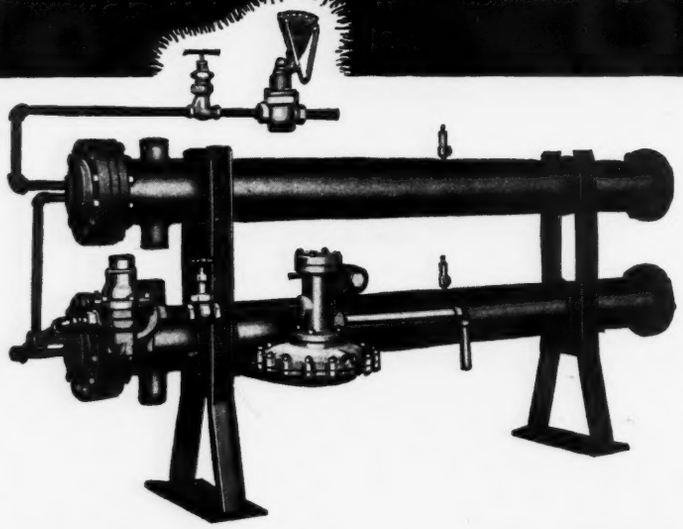
The best proof of this is the remarkable performance of COMPASS belts on industry's hardest drives. From two to five times longer life with practically no stretch is typical. So don't be deceived by the word "cord." The Goodyear COMPASS Cord belt is the only belt in the world with patented balanced cord construction that insures true-running, high flex-life, low stretch and maximum wear. To test COMPASS superiority for yourself, call the nearest Goodyear Mechanical Rubber Goods Distributor.

BELTS
MOLDED GOODS
HOSE
PACKING
Made by the makers of Goodyear Tires

THE GREATEST NAME IN RUBBER

GOODYEAR

The MODERN BLOWDOWN SYSTEM



is CONTINUOUS, AUTOMATIC and operates WITHOUT HEAT LOSS!

HENSZEY, alone, can give you all these FEATURES!

MODERN? Yes . . With high pressure boilers the problem of concentration control has increased. The elimination of scale, priming, foaming, and carry over is essential to efficient boiler operation. Ordinary blowdown is out—it takes a modern system to do the job!

CONTINUOUS? Yes . . Intermittent blowdown is wasteful and always inefficient. The Henszey system allows you to blowdown continuously in the proper proportion to the make up water.

AUTOMATIC? Yes . . The Differential Proportioning valve in a Henszey System automatically proportions the amount of blowdown to the amount of feed or make-up water. This is always under check by the use of Flow Indicators and Feed Water Meters.

WITHOUT HEAT LOSS? Yes . . The Henszey System uses either a two stage temperature exchanger or a combination of flash tank and low temperature exchanger to transfer the heat of the hot blowdown to the make-up water. The economy of this is readily apparent—especially where blowdown would ordinarily have to be done during peak load periods.

The Henszey Feed Water Meter and Flow Indicator can be adapted to the measurement of many other "hard to measure" liquids. What's your problem? Send it in. This may be the "out" you have been looking for.

Send for literature

HENSZEY COMPANY

DEPT. D 4

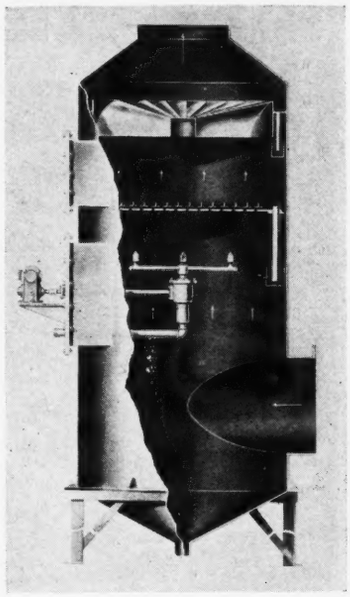
Watertown, Wisconsin

HENSZEY

BOILER WATER CONCENTRATION CONTROL SYSTEMS

Continuing its travel, the gas encounters a plate with coarse perforations. On passing through these, gas velocity is greatly increased and with it the velocity of the dust and water droplets.

The mixture of gas, dust and droplets is shot through the plate perforations directly at square impingement baffles, constantly wet, arranged so that the stream

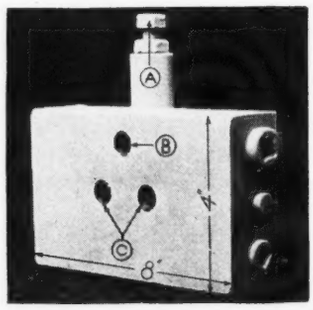


coming through each plate perforation strikes its individual baffle at maximum velocity. Dust particles and water droplets, on impact with the wetted baffle merge with the water surrounding the baffle. Dust particles hit the baffle and are permanently captured in the scrubbing liquid. A liquid overflow pipe, slightly above the level of the baffles, carries off dust-laden water, which leaves at the bottom of the scrubber shell. The gas or air, freed from impurities, is deflected around the baffles and continues upward toward the outlet of the shell, eliminator vanes entrapping any droplets carried upward in the gas stream.

Peabody Engineering Corp, 580 Fifth Ave, New York, N. Y.

Hydraulic Reversible Valve

REVERSIBLE valve is used with a pump and a continuous reciprocating, double-acting cylinder motion. It operates one or more cylinders in parallel; on a closed circuit,



the cylinder with the least resistance moves first, followed by each cylinder in the order of resistance. In the photograph, *A* is the pressure-regulating screw, *B* is the

Here's another

WELL-KNOWN BOILER JOB—

—built with

ELECTRUNITE

REG. U. S. PAT. OFF.

THE MODERN ELECTRIC RESISTANCE WELDED BOILER TUBES

• To the long list of boiler jobs tubed with ELECTRUNITE has been added the $5,000,000 Jane Addams Housing Project in Chicago. The three 400 h. p., 200 lbs. pressure, 388° temperature boilers, engineered by Neiler, Rich & Co. and built by Lasker Boiler & Engineering Corp., both of Chicago, were tubed throughout with these modern boiler tubes.

Make a note right now to learn why leading manufacturers and users specify ELECTRUNITE Tubes for all types of heat transfer equipment. Ask us to tell you about their consistent uniformity, ductility and fine surface...about their low installation costs...and how they provide long, trouble-free service.

Steel and Tubes, Inc.

WORLD'S LARGEST PRODUCER OF ELECTRICALLY WELDED TUBING

CLEVELAND . . . . OHIO

SUBSIDIARY: REPUBLIC STEEL CORPORATION

THIS REGULATOR "Draws Circles"

TO SAVE YOU MONEY

The Masoneilan No. 27 Regulator controls pressure so accurately that it "draws circles" on the charts of recording instruments—and continues to do so day after day—year after year—without continual adjustment for load changes; without shift from control setting between full open and closed; without control time lag; as witness the chart above.

This accuracy, plus ease of placing in operation, plus rugged, fully inclosed construction adds up to a real saving in operating and maintenance expense; a saving which quickly repays the initial cost of the regulator and goes on to increase your profit margin.

Use Masoneilan No. 27 Regulators on primary and secondary steam lines, desuperheating service, make-up service, pump regulation and other services requiring accurate, stable, trouble free control. Ask for Bulletin No. 64 which describes these regulators—and many others in the complete Masoneilan line.

1186 ADAMS STREET
BOSTON, MASS., U. S. A.

MASONEILAN
REG. U.S. PAT. OFF.

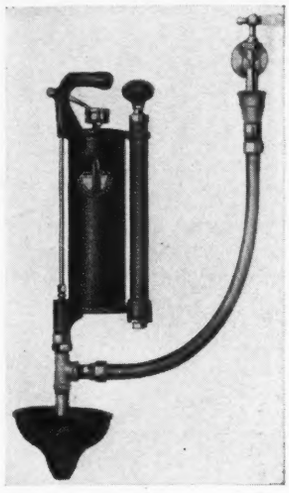
New York · Buffalo · Philadelphia · Pittsburgh · Tulsa
Los Angeles · Toledo · Chicago · St. Louis · Houston

connection from circulating pump, *C* are the connections to the cylinder or cylinders and are alternate discharge and return. Valve is a plunger type with only four moving parts, with practically no pressure loss and permits no stopping or stalling on centers. Action is positive and it operates directly on fluid pressure, frequency of stroke depending on amount of fluid delivered by the pump. Valve is available in various sizes, depending on stroke and pressure required.

Seward & Walcutt, 189 Montague St, Bklyn, N. Y.

Hand-Operated Pressure Pump

HAND-OPERATED pressure pump is said to clear instantly obstructions in sinks, toilets, tubs, showers, and gas and oil pipelines. Hand-operated side pump developes up to 135 lb air-pressure, which is suddenly released by a trigger connection. This pressure acts as a battering ram against the column of water being

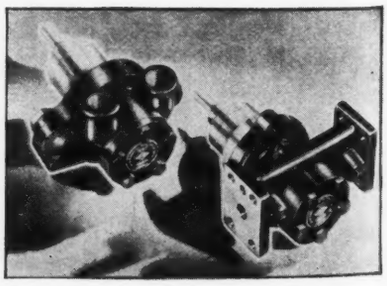


held, dislodging it, and removing it instantly without injury to traps, pipes, or fittings. Grease stoppages are eliminated by using hot water with air pressure, rust can be removed and water flow increased by use of hose connections and ice can be thawed by an alcohol-filling feature.

Empire State Drain Cleaner Corp, Empire State Bldg, New York, N. Y.

Rotary Pumps

"EDCO" vane-type rotary pumps present surfaces for engaging underside of vanes to maintain latter in their effective spanning positions in order to assure constant and uniform delivery. Pumps are said to



IN the records of rod and reel, there's one fellow who always catches 'em more often . . . one angler *stands out* from the rest. "Fisherman's luck," some say . . . but you know there's a lot more to it than that.

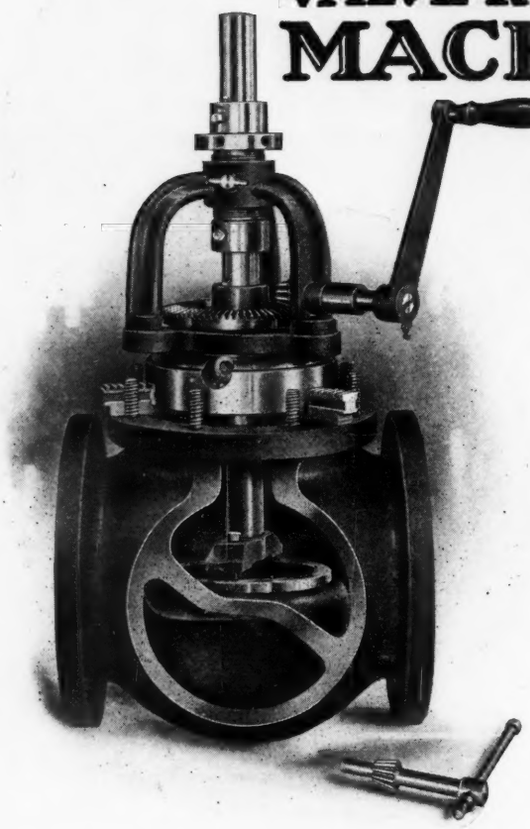
It's the same with packings. *It's not just by chance* that GARLOCK 234 Rotopac Coil Packing stands out. Quality is *built into* this packing at the Garlock factories, so that it will give superior performance and last longer.

Use GARLOCK 234 on your centrifugal or rotary pumps . . . against hot or cold water, caustic solutions and weak acids. You'll like it!

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.
In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

GARLOCK 234

DEXTER VALVE RESEATING MACHINES



READ THIS EXCERPT FROM AN UNSOLICITED LETTER

"Since your agent called on me recently I am writing you what I have wanted to say for many years. We have had one of your DEXTER VALVE RESEATING MACHINES for fifteen years and just to be honest I want to say it has paid for itself over and over many times.

"I could not keep the plant steam and water tight without this machine and with it I can keep valves tight at almost no cost.

"I heartily recommend this machine to any plant where they want to keep valves tight with little cost."

(Name furnished on request.)

Why not ask us for Catalog 24 and let us tell you how you can keep YOUR valves tight at "almost no cost".

Also manufacturers of SWENDEMAN AUTOMATIC SEPARATORS and DRAINS

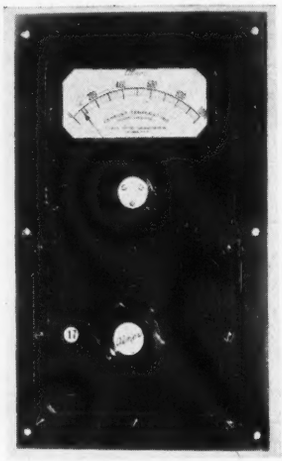
THE LEAVITT MACHINE CO.
10 EAST RIVER ST. ORANGE, MASS.
Canadian Distributors:—
The Canadian Fairbanks-Morse Company Limited
15 Branches Throughout Canada

be silent, since they are gearless, and are furnished in standard capacities of 13, 20, 45 and 90 gal. per hr at 100 lb pressure on No. 1 fuel oil at room temperature, and 1750 rpm.

Eddington Metal Specialty Co, Eddington, Pa.

Multi-Point Pyrometer

"ALNOR" rectangular multi-point pyrometer for checking exhaust temperatures of diesels was designed to provide a moderately priced instrument with multi-point switch, arranged for either back or bottom conduit connection and which would be fully waterproof, fume-proof and dust-tight. Instrument is built to stand considerable strain, but when required to stand severe shocks should be mounted with shock-



resisting movement. Moving element is well damped to prevent pointer from oscillating or swinging under severe vibrations, yet is extremely responsive to temperature change. Scale is 5 in. long with legible figures and subdivisions, and selector switch is set for 8, 17, 25, or 28 points. Has manually operated cold end adjusting screw. Every pyrometer installation requires one thermo-couple for each zone of which a temperature reading is desired. For diesel service, a thermo-couple for each cylinder or exhaust chamber is needed. Type 2804 17-point rectangular style illustrated.

Illinois Testing Laboratories Inc, 420 N La Salle St, Chicago, Ill.

Flame-Failure Indicator

"PHOTO-HEAD", a substitute for standard electrode, affords the same protection in case of flame failure. Contains a photo-electric cell which acts instantly upon flame failure in furnaces, boilers, ovens and heaters. Is hermetically sealed from the combustion chamber, permitting applications to ovens or furnaces above or below atmospheric pressure.

Wheelco Instruments Co, 1929-1933 S Halstead St, Chicago, Ill.

Floor Resurfacer

"MONTMORILLONITE," new concrete repair material, which is mixed with ruggedwear resurfacer, is said to increase coverage

REPEAT ORDERS *tell the story!*

NOTHING tells the story of the success of Springfield Water Tube Boilers any better than the long record of repeat orders from companies who have tried them and now know the advantages offered by these units. Join these users and we know that you, too, will quickly discover why the Springfield boiler is the most practical for many plants!

We will be glad to send you information about Springfield units for any capacity or pressure. Write.

SPRINGFIELD BOILER CO.
SPRINGFIELD, ILLINOIS

CHICAGO • PHILADELPHIA • DALLAS • OSWEGO • CINCINNATI
BATON ROUGE • NEW YORK • BOSTON • DETROIT • PITTSBURGH
MINNEAPOLIS • MEXICO CITY

12 for Implement Maker

TWO WORDS: "Complete Satisfaction!" are used by a prominent midwestern manufacturer of farm implements to describe the performance of Springfield Boilers. As the result of twelve repeat orders, this company now has a total of 15 units in 6 of their plants.

3 for Tobacco Company

"PERFORMANCE better than guaranteed" is one of the important reasons why one of the leading tobacco companies has reordered Springfield Boilers three times since 1928. This company now has a total of five units in two different states.

18 Reorders by Utility

HIGH EFFICIENCY in everyday operation is one of the important reasons why one utility company with scattered properties in the mid-west has placed 19 orders for Springfield Boilers for a total of 30 units.

5 for Municipal Plant

"GOOD STEAMERS" says the chief engineer of one of America's most successful municipal plants. The eight Springfield Boilers in this plant are the result of six orders over a 20-year period.

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SPRINGFIELD BOILERS

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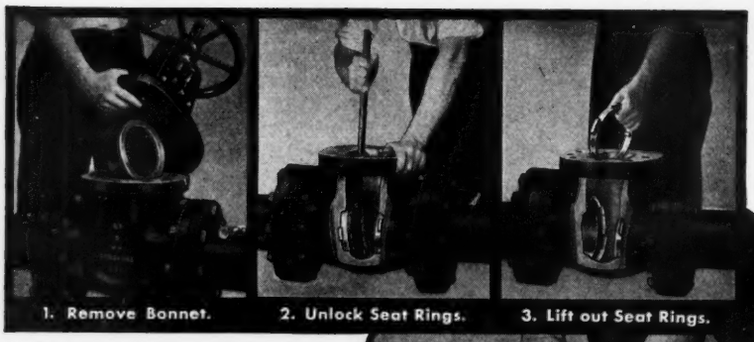

SEAT RINGS CAN BE RENEWED ON THE PIPE LINE BY ONE MAN

The exclusive interrupted thread in the seat rings of Fairbanks Renewable Iron Body Gate Valves makes it possible to unlock worn rings and insert new ones in ten to thirty minutes, depending on the location and size of valve. That makes the valve as good as new, at the small cost of new rings.

Fairbanks Renewable Valves eliminate the time, trouble and expense of removing non-renewable types from the line and paying for a whole new valve when only a small part is worn.

The special high-test semi-steel alloy in these valves has an average tensile strength of 40,000 lbs. per sq. in. Rolled Naval bronze stem, with full cut Acme threads, makes Fairbanks Valves easy to operate at high temperatures.

Bronze lined yoke gland and bronze bonnet bushing prevent corrosion and protect stem from scoring and cutting. Hinged bolts make it easy to repack the stuffing box.

Distributors everywhere sell Fairbanks Bronze and Iron Valves.

Write for Bulletin 102 giving detailed construction and dimension specifications.

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Fairbanks Renewable Valves

capacity per pound, thereby lowering cost per sq ft of patching and resurfacing concrete floors. Is composed of manganese, silica, alumina, and iron and mixes easily

with cement, sand and stone. Can be applied in much the same manner as cement.

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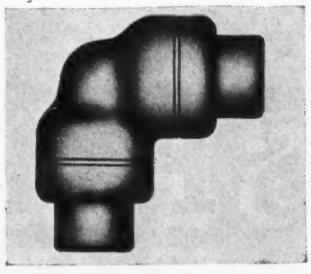
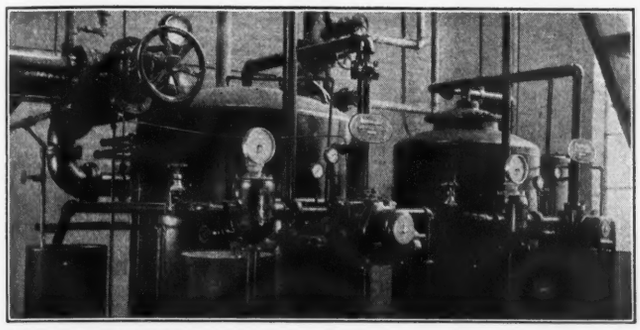
BALL-BEARING swing joints are small, pressure-tight arrangements. Double rows of steel ball bearings carry radial load and keep the packing element compressed by maintaining a pre-regulated thrust upon it. Each joint gives full circle rotation



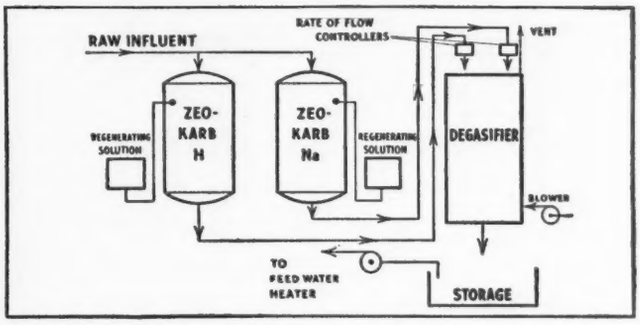
without binding. High pressure joints are steel, tested to 4,000 lb and low pressure joints are brass or malleable iron, tested to 300 lb.

Chiksen Oil Tool Co, Ltd, Fullerton, Cal.

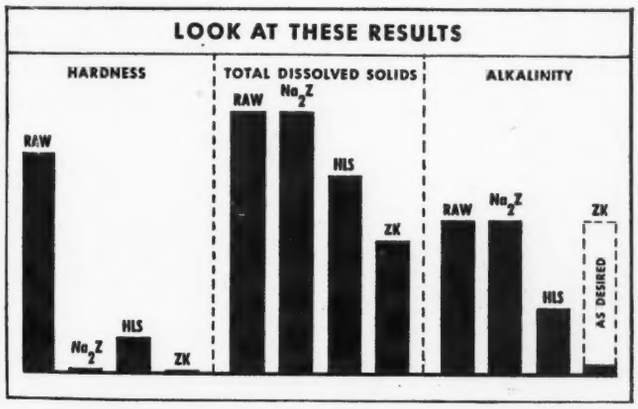
Lick Tough FEEDWATER PROBLEMS with Permutit Zeo-Karb



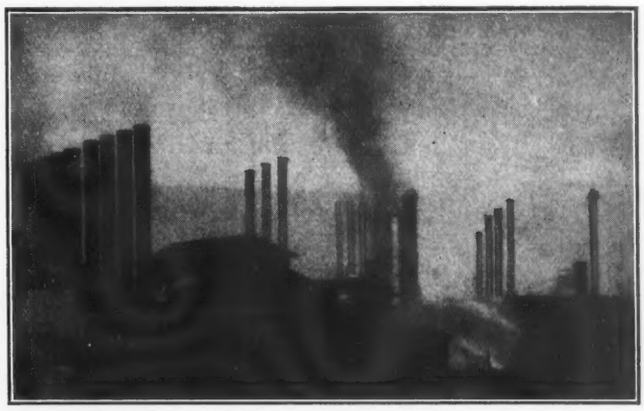
WHAT ZEO-KARB IS. Zeo-Karb is a carbonaceous zeolite, free from silica. It has the advantage of zeolite for removing hardness to zero. It improves on Hot Lime Soda in controlling alkalinity and reducing total solids. It is very resistant to low pH. A typical Zeo-Karb installation is shown above.



HOW ZEO-KARB WORKS. Zeo-Karb H converts all bicarbonate hardness into CO_2 and water. Chloride and sulphate hardness are changed to NaCl and Na_2SO_4 in the blended effluents from the H and Na units. Water of any desired alkalinity may be obtained by varying the proportion of these effluents.



WHAT ZEO-KARB DOES. By ion exchange alone, Zeo-Karb: **1.** *Prevents Scale;* **2.** *Prevents Sludge;* **3.** *Inhibits Corrosion;* **4.** *Lowers Alkalinity;* **5.** *Reduces Total Dissolved Solids.* And does all these better than any other known process!



WHERE ZEO-KARB IS INSTALLED. Today this revolutionary process is making savings under widely varying water and boiler pressure conditions. Among the many industries successfully using Zeo-Karb are: Paper, Public Utilities, Metal Refineries, Chemical Manufacturers, Oil Refineries.

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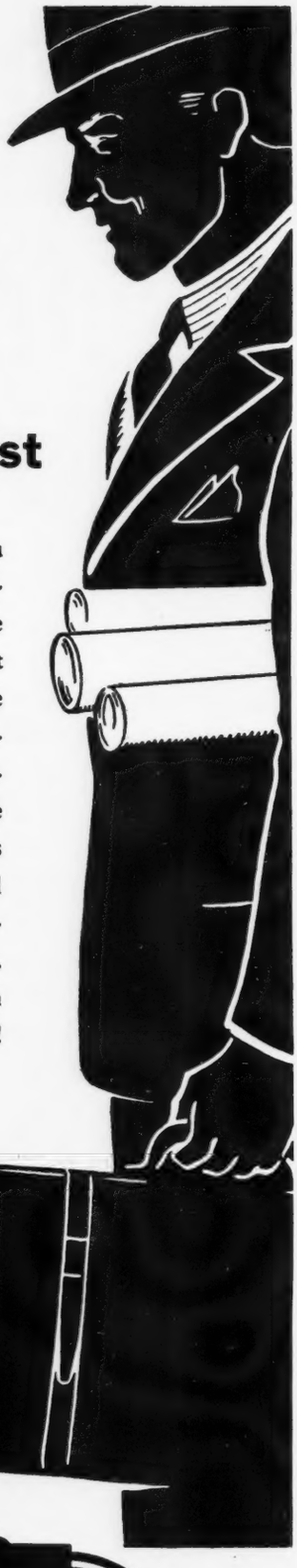

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Readers' Problems

(Continued from page 100)

off. Only alternatives are to provide needed suction head or to allow condensate to cool at expense of efficiency.

Air Leaks

JOHN TINLEY, *Glendale, N. Y.*, suggests possibility of water-temperature rise due to faulty traps but also considers possibility of air leaks in the suction line below the suction valves. Small leaks not at a joint can be filled with a coat of asphalt paint; leaky joints should be remade. Position of leaks will be shown by a candle flame which will be drawn toward them. Be sure proper rubber is used for suction valves working at this temperature. In connection with vapor binding, Tinley also casts a vote for installing a lift fitting after reducing slightly size of the vertical portion of the suction pipe from the receiver, and after making sure that the lower end of the suction pipe is submerged and open.

J L POMATTO, *Peru, Ill.*, says troubles with pumps running jerkily, in his experience, usually come from water too hot for the lift, suction pipe reduced in size, or foot valve. Foot valves should be of simple construction and one size larger than the area of the suction pipe which should, in turn, be one size larger than the suction connection of the pump, and reduction to the pump chamber should be made with a conical fitting rather than a bushing. Obstructions in lines and in the pump chamber may cause the trouble.

C C LYNDE, *Kilgore, Texas*, explains the way high water temperature and suction lift combine to cause erratic operation and points out that this trouble is not peculiar to duplex pumps, but would also greatly hinder or comp'etely incapacitate a centrifugal or positive-pressure impeller unit.

A L WESTCOTT, *Columbia, Mo.*, also diagnoses high temperature as the trouble and feels that discharge from some of the traps probably contains steam. Based on 25 lb abs pressure in the traps, he calculates mixture in the discharge will be about 3% steam and unless distance from traps to reservoir is considerable, return water will be at or close to the boiling point.

R L BROWN, *Sloat, Calif.*, suggests putting suction of pump under positive head to cure steam binding, and also points out that this will show up any leaks in suction piping, as water will seep out small holes.

Too Much Vacuum

G F MATTHES, *University, La.*, believes that by renewing the packing on the water-end piston, higher vacuum is developed on the suction stroke than when packing is worn. Increased vacuum causes some of the hot water drawn into the cylinder to flash into steam due to the

SAMCO, The Cost-Cutter Says—

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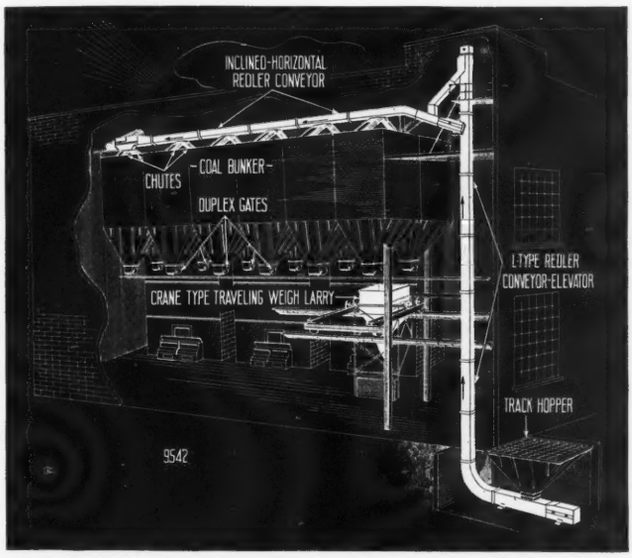

SIMPLICITY THE KEYNOTE OF THIS REDLER POWER PLANT

This S-A equipped power plant of Chicago Housing Authority's Julia Lathrop project features but two REDLER Conveyor-Elevators to handle coal from hopper to bunker. REDLERS also handle other pulverized, granular and small lump materials. REQUEST CATALOG 42!

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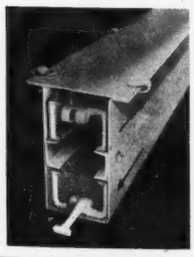

This cross-section through a horizontal REDLER Conveyor shows how coal and other materials are handled en masse, in a solid column. Material is moved along in steady flow, without slippage. En masse action permits choke feed . . . no Feeders required.

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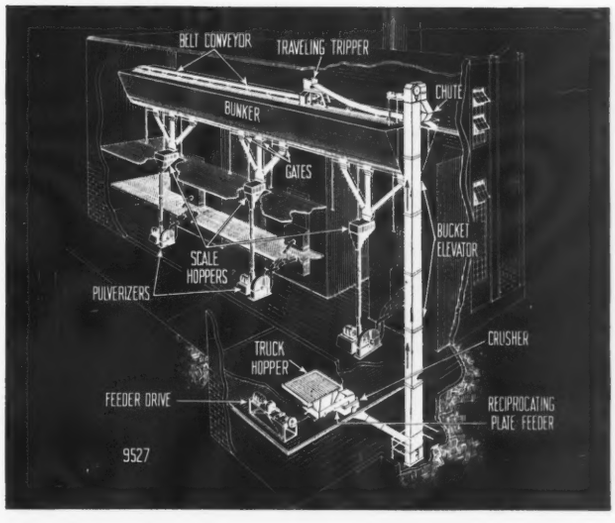
Harvard University's entire Medical Center depends on S-A Bucket Elevator, Belt Conveyor and auxiliary equipment to take care of all coal handling requirements. ASK FOR BELT CONVEYOR-BUCKET ELEVATOR CATALOG 47!



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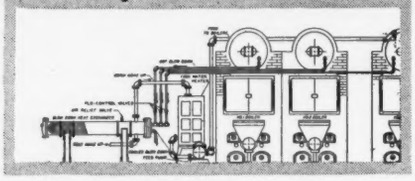
For that other large group of plants where the boiler water concentration consists chiefly of sludge and mud, the answer to the wet steam problem is the time-tested Elgin Sludge Deconcentrator.

Clean, dry steam without heat loss



This equipment removes suspended impurities by means of an ingenious precipitation chamber—also without heat loss.

Along with these two methods of dealing with the two forms of concentration goes the wide range of Elgin Boiler Water Treatments. The Elgin line includes both internal and external treatments. Elgin individualized internal boiler water treatments are ideally adapted for use with Continuous Blowdown and Deconcentrator Systems. Elgin Softeners are also used extensively in connection with these two systems.

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SYSTEM OF BOILER WATER CONDITIONING

lower pressure. When the piston starts its discharge stroke little resistance to compression is offered by the steam-water mixture, causing the piston to speed up. When the steam is reduced in volume, the mixture becomes harder to compress, offers resistance to the piston, and slows it down. Initial speeding up and later slowing down produce the jerky pump motion noticed. The amount of suction head required can be determined from page 77, June 1938, POWER.

W I HAYNES, *Bronx, N. Y.*, points out that each foot of suction lift requires 1 in. of vacuum and that under about 6 in. of vacuum, water will flash to steam in the neighborhood of 190 F. He then explains how steam binding affects pump operation, much in the way described by Matthes, above. G F BRILL, *Beaumont, Tex.*, summarizes many other answers by telling CAC to raise the receiver or lower the pump, check the suction piping for leaks, check the valves, and check the traps for blow-**through.**

F W NEUBRANDER, *Cleveland, Ohio*, casts another vote for suction lift as a cause of trouble and points out that pumps handling hot water should have ample area of suction valves and suction piping, and should run at low piston speed. If pump has a jumpy action at beginning of each stroke and then follows through steadily, it is probably caused by friction of suction and discharge valves preventing quick seating, resulting in slip. Pump should be fitted with new valves and springs and the lift of the valves should all be the same, or in this case the suction valve can have a higher lift.

J C PORTER, *Saltville, Va.*, thinks CAC is trying to lift water at about 200 F with a suction lift of about 3.5 lb, just about right for vapor binding. To correct trouble, pump must be lowered or sump raised, but if present set-up is nearly at the point where pump suction pressure is greater than the vapor pressure of the water at the temperature maintaining, weaker springs on suction valves may be all that's needed.

Tap Suction Line

ALLAN WOKES, *Manitoba, Canada*, suggests that if it isn't practical to insure a positive suction head, CAC might tap the suction line for a small pipe, allowing the makeup water to feed directly to the pump. A valve on this line would regulate amount of water necessary to steady the pump.

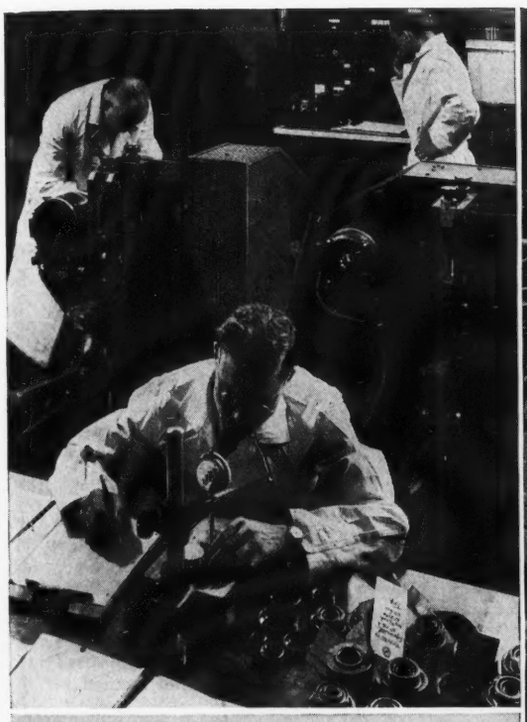
F W CARTER, *Waterbury, Conn.*, explains the action of steam binding as Matthes and Haynes did previously, and thinks that if CAC can raise his reservoir 8 ft above the pump, his troubles will be over.

C S STOUFFER, *Pottstown, Pa.*, also blames formation of steam due to lowered pressure as the cause of the trouble, and if impractical to change relative positions of tank and pump, he suggests adding cold water to keep temperature down.

J J WYNHOFF, *Racine, Wis.*, feels it is almost impossible to expect to lift water with any type of pump under such condi-

RESEARCH IN LUBRICATION

has created an extra margin of safety in GULF PRODUCTS



This experimental equipment — designed and built in the Gulf Research Laboratory — is used to test bearing lubricants under a wider range of operating conditions than are encountered in actual service. Thus Gulf's field engineers are able to recommend lubricants for specific applications which not only meet the prevailing conditions, but provide an *extra margin of operating safety.*

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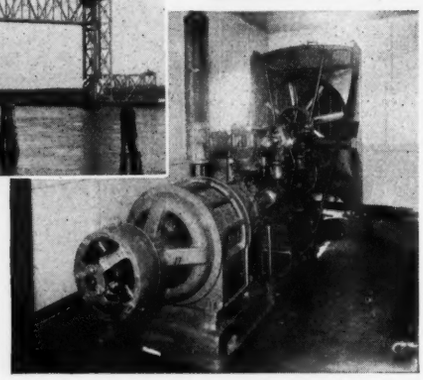

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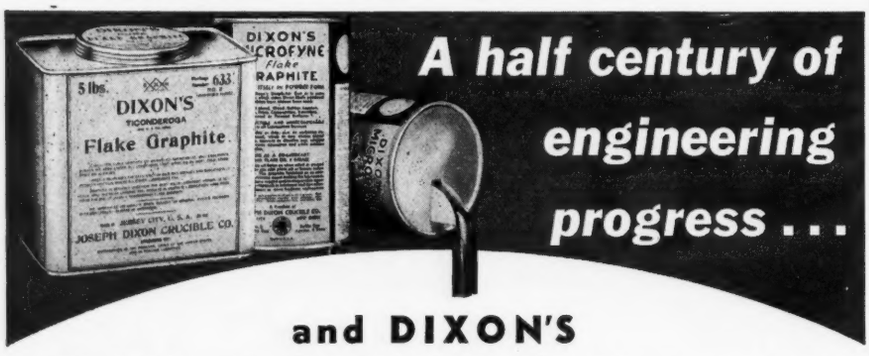

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tions, and that to pump any hot water, a slight positive head is necessary, amount depending on temperature of the water. If the reservoir can't be raised, he suggests gathering the condensate in a closed receiver under about 5-10 lb pressure.

T W Bean, *Vallejo, Calif.*, says that several defects in the pump itself, other than worn water packing, may contribute to CAC's trouble. Water valves, water cylinder, steam-piston rings, operating gear, may be worn or deranged. However, if these items are found ok, he would look for trouble at the pump suction, due to high water temperature. This means checking each steam trap and repairing any found defective. A hotwell thermometer will warn when returns are coming back too hot for the pump to handle.

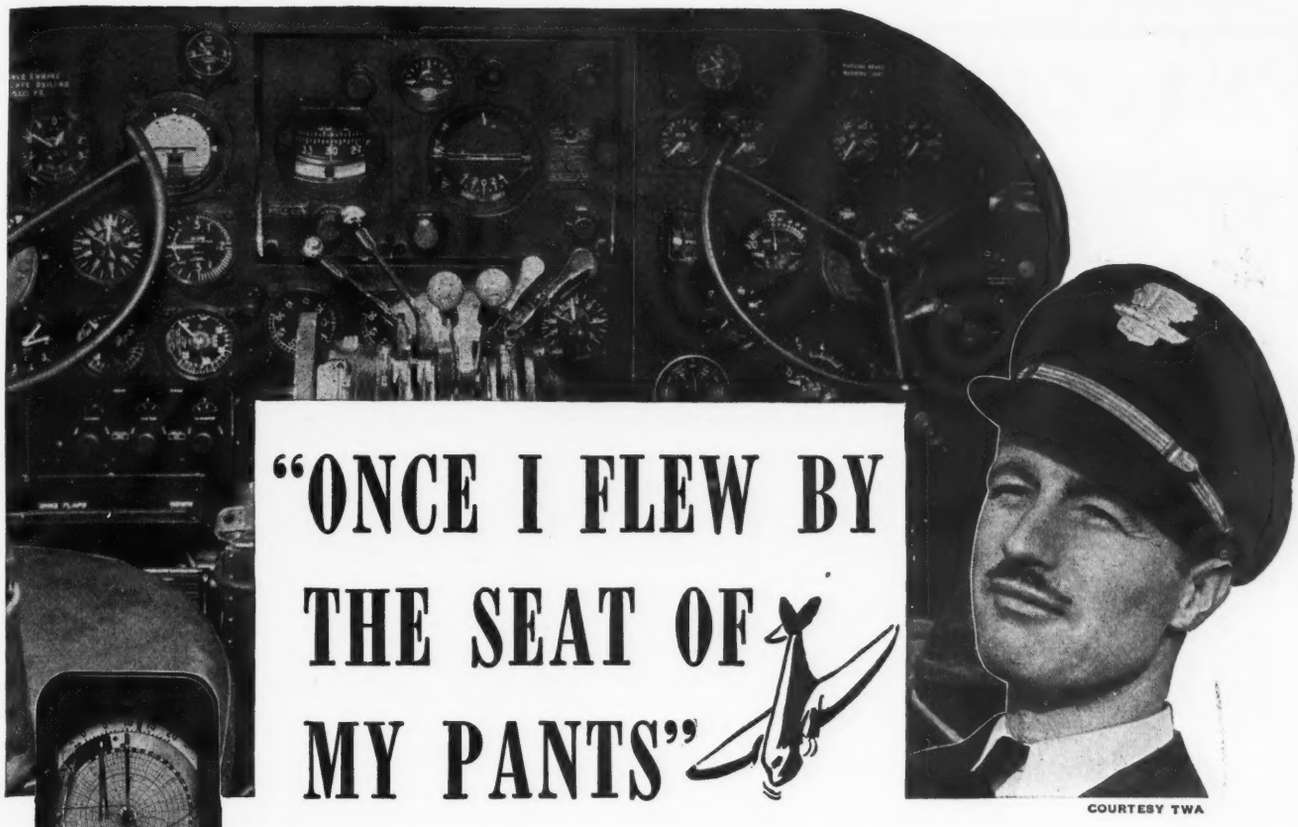
W B Freeman, *Raleigh, N. C.*, summarizes the situation neatly—"the pump must lift water 5-6 ft and overcome the frictional loss in the pipe. Since the water comes directly from steam traps, temperature is near the vaporization point at atmospheric pressure. To lift the water, there must be a decreased pressure in the pump, and this decrease lowers the vaporization temperature below that of the water changing it to steam. The pump cylinder fills with steam and since steam is easily compressed the pump runs jerkily."

R C Clock, *Freeport, Ill.*, agrees with Wokes that one solution would be to add cold makeup water directly to the feed-pump suction line near the point where the line comes out of the hotwell, even though this method lowers feed temperature to the boiler. A better method would be to use a motor-driven submerged-type centrifugal sump pump to pump water from hotwell to an elevated tank or feedwater heater above level of the feed-pump suction. This would allow hot water to be fed to the pump suction under a positive head.

W J Blyth, *Omaha, Neb.*, thinks high water temperature is the root of CAC's troubles, but suggests measuring the temperature with a thermometer before jumping to conclusions. If above 150 F, the water is too hot; it can be cooled by the method previously suggested by Wokes and Clock, or the reservoir can be raised.

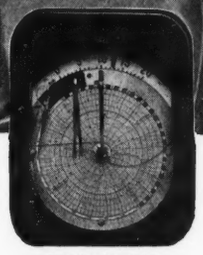
Check Pump Condition

H W Benton, *Hartford, Conn.*, finds the duplex steam pump a reliable pumping unit, but it will not operate smoothly unless its mechanical condition is satisfactory. First, resistance to motion, which includes friction and pressure, must be equal for each side of the pump and for each of the four strokes. Any differences in resistance will have a bearing on length or speed of stroke. Differences in resistance may be caused by worn rods or by worn cylinder bores. Both steam cylinder and water cylinder bores must be of uniform diameter through the entire length and center line through these bores must be straight, on both sides of pump. It is also necessary that both water and steam piston rods be of uniform dia-



"ONCE I FLEW BY THE SEAT OF MY PANTS"

COURTESY TWA



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Write for our recently issued Bulletin 1580-P, entitled *"MEGGER" INSURANCE.*

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ELECTRICAL INSTRUMENTS

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* *Photo by Courtesy of The Hartford Steam Boiler Inspection & Insurance Co.*

meter throughout their entire length so that no wedging action or binding can occur due to shoulders near the end of the stroke resulting from wear.

Steam pistons must be of equal mechanical design so as to offer equal frictional resistance and must be equally steam tight. A similar condition must exist in the pump cylinders. If the foregoing conditions exist and if "D" slide valves are steam-tight and correctly set, the pump should operate smoothly and satisfactorily. If not, cause of the trouble may be found in incorrect valve-spring tension or a wrong location of the pump relative to source of supply.

A suction lift with hot water will cause vapor binding which might also be caused by strong spring tension on the suction valves. Thus the less-than-atmospheric-pressure condition established in the pump cylinder during the intake stroke might cause incoming water to flash to steam at the instant water gets through the restricted valve opening, because of excess tension on the valve spring. Thus, this evaporation might not occur in the suction pipe, but in the pump cylinder on the intake stroke.

CAC should check his pump carefully for frictional resistance, to be sure that it is equal for all strokes, and that steam pistons are equally tight. It might also be a good idea to use a very light spring tension on the suction valves.

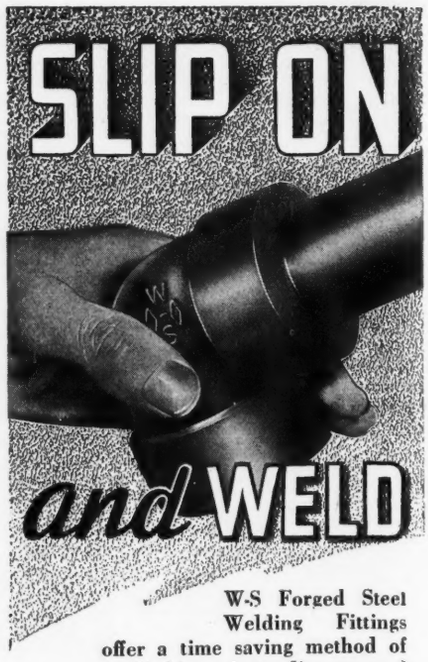
Check Steam Valves

GEORGE BLUM, *Marissa, Ill.*, thinks that the lift might be handled if water temperature doesn't exceed 200 F and suggests checking setting of steam valves. As a maintenance man he once found a pump operating like CAC's jerking crazily and not making a full stroke. On removing steam heads, he found that adjusting nuts on the valve rods were set to allow no lost motion. Valves had not been seated for some time prior to the change in travel and had climbed the ridges left at the ends of travel by wear, with the result that anything could have happened. In this case, it was a jerky inclination of the pistons to travel both ways at once.

W C SOWELL, *Fresno, Calif.*, sums up possible sources of CAC's trouble: (1) too much or too little play in valve motion, (2) improper setting of steam valve —with steam pistons and slide valves in central positions the rocker arms should be vertical, (3) leaky or sticky pump valves, (4) worn cylinder liners, and (5) incomplete submergence of suction line.

CORRECTION

Through typographical error, the formula for diameter of line shafts, "Have You Got Your Bearings on Line Shafts", page 75, March 1939, Power, was given as $D = Hp \times 83.7$. This should have been $D = \sqrt[3]{Hp} \times 83.7$



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With W-S Fittings the socket end supports the pipe and provides for positive alignment. The position of the weld facilitates the welding operation and also removes the danger of the formation of welding icicles. This, together with the fact that the bore of the fitting matches the bore of the pipe, assures unobstructed flow.

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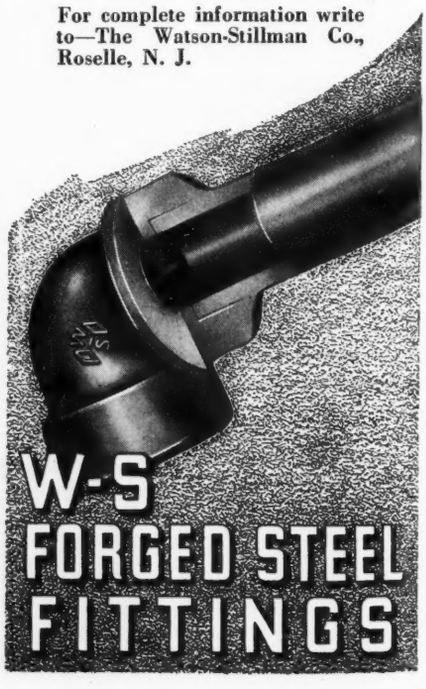
For complete information write to—The Watson-Stillman Co., Roselle, N. J.



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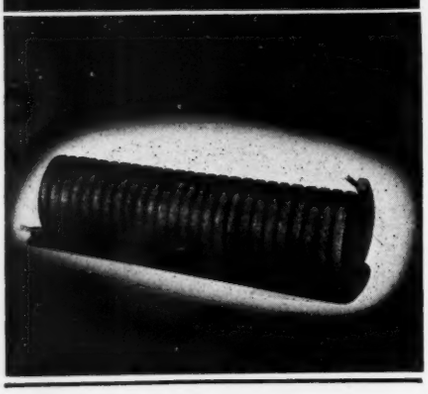

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SEA-RO

STRAWS

(*Continued from page* 104)

plant, including radial concrete stack. Installation will include boiler units, combustion-control apparatus, and pumps. Entire project will cost about $300,000. Albert Kahn, Inc, New Center Bldg, Detroit, Mich., architect and engineer.

Snider Packing Corp, 2203 Home Ave, Marion, plans 1-story addition, 60 x 100 ft, to be equipped as cold-storage and refrigerating plant, with locker system. Cost close to $45,000. D R Cecil, manager.

Crawfordsville contracted Condenser Service & Engineering Co, Hoboken, N. J., at $34,960 for condenser for municipal power plant. Awards for other equipment will be made soon. Entire project will cost about $225,000. Commercial Testing & Engineering Co, 307 N Michigan Ave, Chicago, Ill., consulting engineer.

Rensselaer will begin work soon on addition to power plant. Additional equipment will be installed. Cost over $75,000. John W Moore & Son, Indiana Pythian Bldg, Indianapolis, consulting engineers.

IOWA——John Morrell & Co, Ottumwa, plans 7-story and basement addition, to be equipped as a cold-storage and refrigerating unit. Erection contract awarded to Stark Building Co, Cedar Rapids, at $289,000, exclusive of equipment, for which awards will be made separately. Will begin work soon. Henschien, Everds & Crombie, 59 E Van Buren St, Chicago, architects and engineers.

Sibley contracted Murray Iron Works Co, Burlington, at $31,773 for 750-kw turbine-generator for addition to power plant; also made award to Allis-Chalmers Mfg Co, for surface condenser, to Schubert-Christy Corp, for cooling tower; and to Electrical Engineering & Construction Co, Des Moines, for switchboard. Young & Stanley, Inc, Muscatine, consulting engineer.

Ames has low bid from Lilie-Hoffman Cooling Towers, Inc, at $12,748 for cooling tower for power station, and will soon make award. Complete project will cost $170,000, and will include new 3000-kw steam turbine-generator unit.

H J Barden, Toronto, is head of project to construct and operate cold-storage and refrigerating plant, with locker system. Cost about $35,000. Work will begin soon.

Iowa Power & Light Co, Des Moines, plans following improvements to light plant: distribution system, $40,000; heating plant, $66,000; gas-distribution system, $8,000.

Woodbine is running preliminary surveys in connection with proposed municipal light and power plant and distribution system. The Harrington Engineering Co, Omaha, has been retained for this work.

New London is considering municipal power plant, using diesel-generator units. Surveys and estimates of cost will be made soon.

Iowa Public Service Co, Sioux City, plans artificial gas-distributing station at Waverly. Work will be carried out in May. Cost close to $35,000.

KANSAS——Ottawa recently awarded contract to Riley Stoker Corp for furnishing and installing two new boilers in power plant. Contract price was $101,-261.

Larned will award contract for 1500-kw steam turbine-generator unit and 3000-sq-ft surface condenser for power plant. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Bd of Public Utility Commissioners, City Hall, Kansas City, Kan., James R Donovan, manager, plans new pumping station for water system, including pumping units for gross capacity of 25,000,000 gal. per day. Cost over $500,-000. Burns & McDonnell Engineering Co, 107 W Linwood Blvd, Kansas City, Mo., engineer.

Marion is considering improvements in power plant, including installation of diesel-electric unit to replace present equipment. Estimates of cost being made and bond issue will be arranged soon.

KENTUCKY——Corbin plans installation of centrifugal pumps, motors, pump station bldg, distribution system addition, etc, for municipal power plant. Burns & McDonnell Engrg Co, Cincinnati, Ohio, engineers.

Fayette County Bd of Trustees, Lexington, let contract to Gilson-Taylor, Inc, 755 E Third St, Lexington, for central-heating plant at sanitarium on George-

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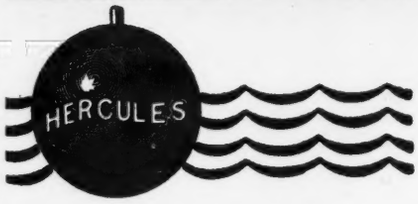

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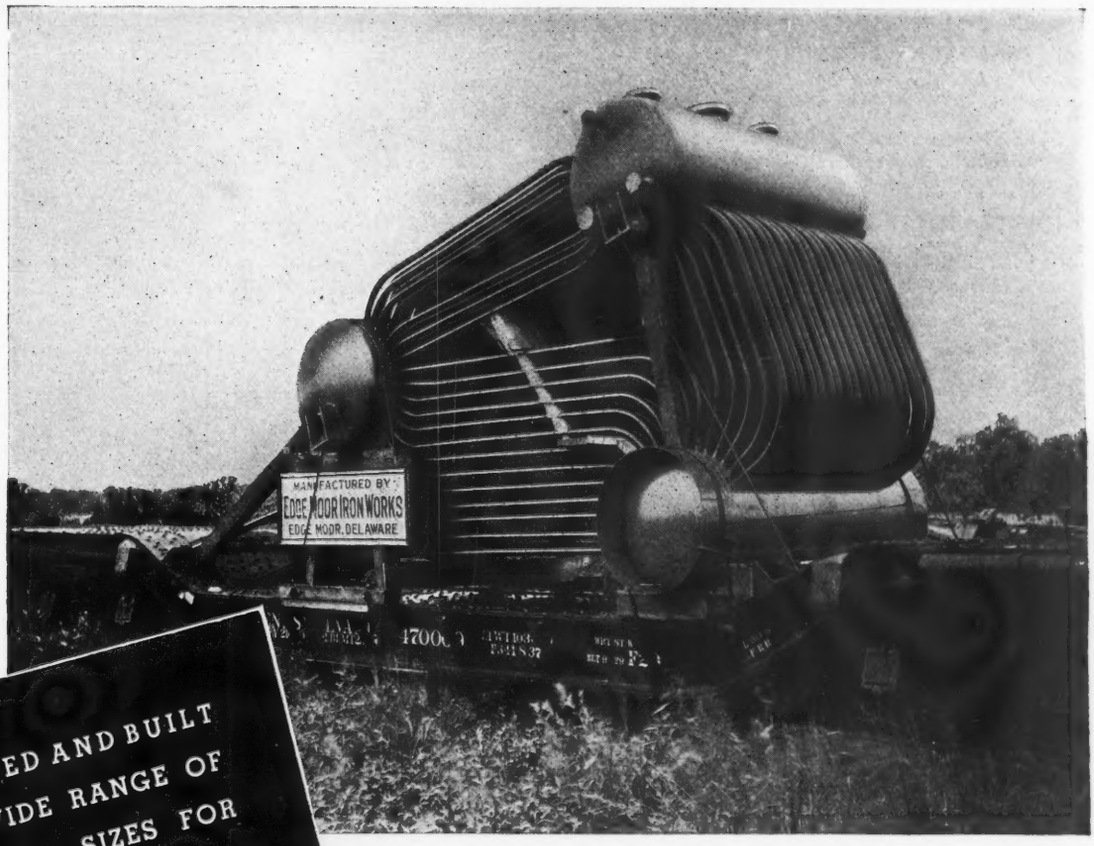

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town Pike. Cost about $65,000. Frankel & Curtis, McClelland Bldg, architects.

Nicholasville plans improvements in power plant. Cost about $85,000. Financing has been arranged in part through Federal aid. J S Watkins, Lexington, consulting engineer.

Frankfort Municipal Housing Commission, Frankfort, John W Brooker, secretary, plans central-heating plant for new housing development. Cost about $450,000. Hugh Meriwether & Associates, Radio Bldg, Lexington, architects.

LOUISIANA——Ruston plans power plant and waterworks station, to include a 1000-hp engine-generator unit and pumping machinery. Cost about $125,000. Financing being arranged.

Southern Pecan Co, 516 Magazine St, New Orleans, plans installation of cold-storage and refrigerating department in new 2-story plant, 150 x 150 ft, at Brookhaven, Miss. Cost over $50,000.

Bd of Trustees, Tulane University, New Orleans, contracted Equitable Equipment Co, 410 Camp St, at $23,943 for central-heating and air-condition systems in auditorium building, to cost about $250,000. Favrot & Reed, Nola Bldg, architects.

State Hospital Bd, New State Office Bldg, Baton Rouge, A R Johnson, director, plans central-heating plant in charity hospital at Monroe, consisting of main 3-story building and smaller structures. Cost about $750,000. Edward F Neild, City Bank Bldg, Shreveport, architect.

Treasury Dept, Washington, D. C., has low bid from Enterprise Electrical Co, Inc, 826 Baronne St, New Orleans, at $116,013, for electrical and mechanical equipment installation and changes at U. S. Customhouse. Award scheduled to be made soon.

MICHIGAN——Northland Natural Gas Co, Evart, plans pipeline system for gas distribution at Reed City, where franchise has been secured, including control station.

Fruehauf Trailer Co, 10940 Harper Ave, Detroit, plans 1-story branch plant at Los Angeles, Cal., for motor trailer production, including parts manufacture and assembling. It will approximate 100,000 sq ft floor space. Cost close to $250,000.

State Dept of Institutions, State Office Bldg, Lansing, Harold D Smith, budget director, will award contracts soon for equipment for power house at institution at Lapeer. Cost about $25,000. E R Little Co, Ford Bldg, Detroit, consulting engineer.

State Dept of Institutions, State Office Bldg, Lansing, Harold D Smith, budget director, will award contracts soon for extensions in power house at state hospital, Kalamazoo, including boiler unit. Cost about $100,000. Cummins & Barnard, State Savings Bank Bldg, Ann Arbor, consulting engineers.

MASSACHUSETTS——G & C Merriam Co, 12 Broadway, Springfield, book publisher, plans central-heating plant in administration building at 34-51 Federal St. Cost about $200,000. To ask bids in spring. Wallace E Dibble, 21 Besse Pl, Springfield, architect.

Bd of Directors, State Soldiers' Home, Crest Ave, Chelsea, considering new power plant at institution. Cost about $200,000. L F Quigley, commandant.

MINNESOTA——Halsted will award contracts soon for boilers, etc, for municipal power plant. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

Alexandria contracted Power Service Corp, Wesley Temple Bldg, Minneapolis, for boiler units, coal and ash-handling equipment and combustion-control apparatus for steam-heating plant. Cost about $162,400. Burlingame, Hitchcock & Estabrook, Inc, Sexton Bldg, Minneapolis, consulting engineer.

Bd of Trustees, Naeve Hospital, Albert Lea, plans addition to boiler plant and mechanical laundry unit. Bids scheduled to be asked in April. Cost about $50,000. LeRoy Gardner, Home Investment Bldg, architect.

MISSISSIPPI——Laurel Housing Authority plans central-heating plant for housing development. Project will cost about $500,000. Landry & Matthes, Connecticut Bldg, Hattiesburg, architects.

MISSOURI——St. Louis recently awarded contract to S C Sachs Co, 817 North Ninth Street, St Louis, at $57,494.50 for alternating current and direct current electrical distribution system at City Hospital No. 1 at 1515 Lafayette Avenue.

Lathrop recently awarded contract to Fairbanks, Morse & Co for furnishing

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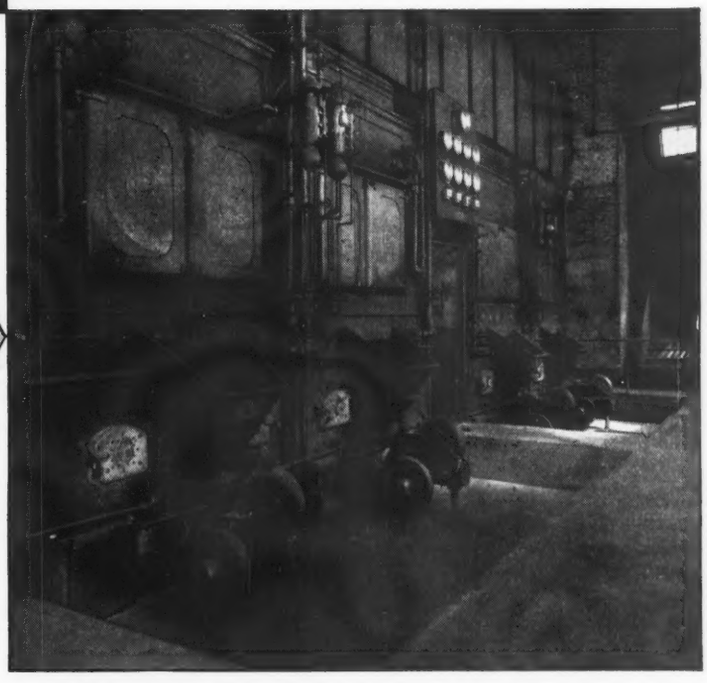

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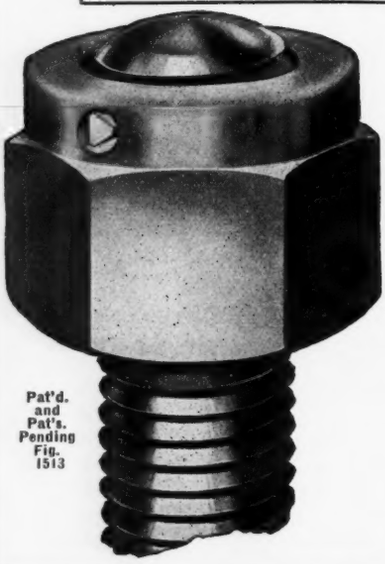

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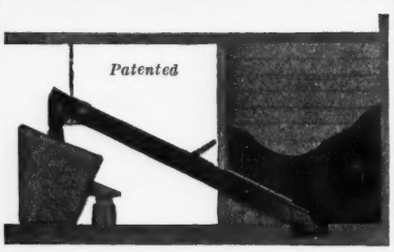

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and installation of equipment for a municipal light and power plant. Contract price was $68,818, award subject to PWA approval. E T Archer & Company, Kansas City, consulting engineers.

Macon will award contracts for improvements in municipal power plant, with installation of new boiler unit, stoker, turbine-generator, condenser, etc. Cost about $200,000. Beaumes Engrg Co, Railway Exchange Bldg, St Louis, consulting engineer.

Eldorado Springs plans power plant, using diesel-generator units. Arrangements being completed for acquisition of local distributing system. Cost about $120,000. Bids scheduled to be asked soon. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

Pleasant Hill plans municipal power plant, using diesel-generator units, and will take bids soon. City arranging for purchase of local distributing system. Entire project will cost about $155,000. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

NEBRASKA——Laurel plans improvements in municipal power plant, including new diesel engine unit. Work will be carried out in spring.

NEW HAMPSHIRE——Bill filed with New Hampshire Legislature for $57,000 provides for repairs and improvements at State Industrial School in Manchester.

NEW YORK——State Dept of Social Welfare, State Office Bldg, Albany, will award contracts soon for new power house at state training school for girls, Hudson, N. Y. Cost estimated at $200,000. W E Haugaard, architect; and T F Farrell, engineer, both first noted address.

United States Tobacco Co, 630 Fifth Ave, New York, N. Y., plans power house and new multi-story addition to factory on S Nineteenth St, Richmond, Va. Cost reported over $300,000. Schmidt, Garden & Erickson, 104 S Michigan Ave, Chicago, Ill., architects.

New York Worlds Fair 1939 plans 72 air-conditioning systems at total cost of $1,500,000, with capacity of 5,412½ tons of refrigeration, compared with Century of Progress, 1933, which had 750 tons of refrigeration.

American Tobacco Co, 111 Fifth Ave, New York, contracted General Electric Co for generating unit for power house at plant at Durham, N. C.; also let contract to Babcock & Wilcox Co for boilers. Project will cost about $200,000. Francisco & Jacobus, 511 Fifth Ave, New York, consulting engineers.

Socony-Vacuum Oil Co, 26 Broadway, New York, plans power house and pumping station at oil refining plant at Shelby, Mont. Plant will be equipped for handling about 2000-bbl of crude oil daily. To begin work soon. Cost reported over $500,000.

NORTH CAROLINA——Bd of Directors, Goldsboro State Hospital for Negroes, Goldsboro, R M Purser, business manager, contracted Riley Stoker Co, at $25,500 for boiler units for power house at institution, where new buildings will cost about $960,000.

OHIO——Monroeville has voted bond issue of $42,820 for municipal power plant, to cost about $80,000, remainder of fund to be secured through Federal aid. Diesel-generator units to be used. William C Kammerer, 1900 Euclid Ave, Cleveland, consulting engineer.

North Baltimore, has approved bond issue of $221,000 for new municipal power plant. Cost about $300,000, remainder of fund to be secured through Federal grant. Work to begin in spring.

Piqua contracted Miller & Fry Co, Piqua, for improvements in power plant. Additional equipment will be installed, awarded under separate contracts. Cost about $225,000. Burns & McDonnell Engineering Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

City Ice & Fuel Co, 6611 Euclid Ave, Cleveland, is considering cold storage and refrigerating plant at West Ave and Elm St, with locker system. Cost estimated about $40,000.

Amherst voted bonds for $145,000 for power plant, to include two 345-kw and one 125-kw diesel-generator units, including switchboard, etc. To make awards soon. Floyd G Browne, Marion, consulting engineer.

Wellston contracted Worthington Pump & Machinery Corp, for turbine-generator unit for power plant at $59,524. F W C Bailey, 20 S Third St, Columbus, consulting engineer.

Clyde contracted Elliott Co for surface

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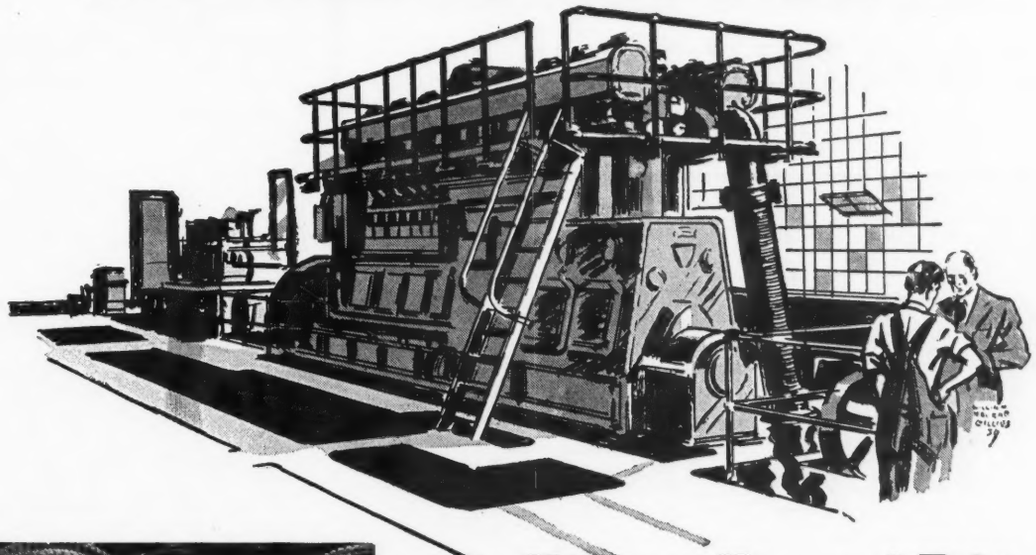

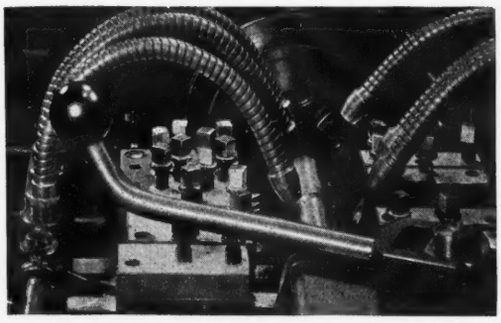

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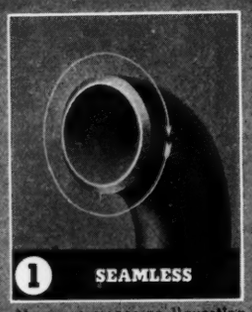

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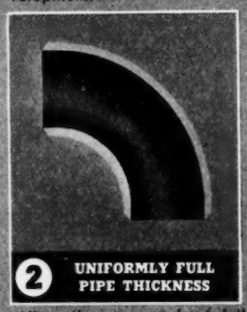

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All sections are at least full pipe thickness. There is no thinning of the back wall.

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A typical refinement based on thorough-going research.

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This feature, pioneered by Taylor Forge, removes the weld from the curved section—also makes all welding a simple, straight-away operation.

8 A FULL LINE

The Taylor Forge line contains the largest number of types in the largest range of sizes and thicknesses.

condenser at $14,200, for addition to power plant. Froehlich & Emery Engrg Co, Second National Bank Bldg, Toledo, Consulting engineer.

Bd of Trustees, Kent University, Kent, contracted Schirmer-Peterson Co, Cleveland, for 2-story addition, 60 x 65 ft., to central-heating plant at institution. Equipment awards will be made separately. Harry A Fulton, 5716 Euclid Ave, Cleveland, architect.

OKLAHOMA——Tecumseh plans municipal power plant, using diesel-generator units. Cost reported close to $50,000. H H Mahler, Tulsa, consulting engineer.

PENNSYLVANIA——Lehigh Portland Cement Co, Allentown, plans improvements in different mills in various parts of country during 1939. Cost about $3,000,000. Appropriation being arranged.

Arctic Locker System Co, York, recently organized by V C Patterson, 112 N Keesey St, and associates, contracted York Ice Machinery Co, York, for equipment for new 1-story cold-storage plant at Jefferson and Juniper Sts. Cost close to $50,000.

American Viscose Corp, Marcus Hook, approved plans for new 4-story addition to viscose rayon mill at Roanoke, Va. Cost about $160,000.

SOUTH DAKOTA——Dept of Interior, Indian Service, Washington, D. C., contracted National Supply Co, Springfield, Ohio, for diesel unit for Rosebud Agency, Rosebud, at $14,072.

TENNESSEE——Old Hickory Ice Co, 1307 Florida St, Memphis, plans 1-story ice-manufacturing plant on S Third St, with initial capacity of 25 tons per day. Cost about $35,000.

J F Young, Ripley, heads project to construct and operate cold-storage and refrigerating plant, with locker system. Cost about $40,000.

TEXAS——Construction Service, Veterans' Administration, Washington, D. C., is asking bids for pumping station and water-treatment plant at institution at Amarillo, including zeolite water-softening equipment.

San Antonio Portland Cement Co, 1301 W Martin St, San Ontonio, plans addition to power house at mill, to be used for fuel oil storage and distribution. Cost about $35,000. W E Simpson Co, Milam Bldg, consulting engineer.

Bd of Victoria County Commissioners, Victoria, plans central-heating plant in 4-story county jail. Cost about $100,000. Work will be carried out in spring. K J Leffland, Welder Bldg, architect.

VIRGINIA——Kenneth W Markwell, representing PWA, approved contracts totaling $2,000,000 to General Electric Co, Schenectady, N. Y., and the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., for equipment for the Santee-Cooper power house at Pinopolis.

Chesapeake-Camp Corp, Franklin, approved plans for two 1-story additions to kraft paper mill. Cost over $200,000.

WASHINGTON——Bremerton Creamery Co, Bremerton, plans modernization in milk products plant. Cost reported close to $30,000.

Olympia Veneer Co, Olympia, plans boiler plant at proposed plywood mill at Willamina, Ore. Mill will comprise several 1-story units. Cost about $500,000. To operate plant under name of Pacific Plywood Corp, an affiliated interest.

Robert Butterfield Co, Terrace Heights, Yakima, plans rebuilding of portion of cold-storage and fruit-packing plant, recently destroyed by fire. Loss estimated at close to $30,000.

WISCONSIN——Kimberly-Clark Corp, N Commercial St, Neenah, let contract to C R Meyer & Son Co, 50 State St, Oshkosh, for excavations for addition to power house at branch paper mill at Niagara, and will make award soon for superstructure and equipment. Will include two boiler units, with provision for third boiler at later date. Cost reported over $175,000.

Greenville Frigid Locker Co-operative Association, Greenville, has acquired 1-story building and will remodel and equip for new cold-storage and refrigerating plant. Cost estimated about $35,000.

Arcadia will make award soon for cooling tower for power plant, where work is under way on an addition for increased capacity. Cost about $50,000. Helmick, Eduskuty & Lutz, Essex Bldg, Minneapolis, Minn., consulting engineer.

Marathon will award contracts for deep-well pumping machinery with dual drives for waterworks pumping station. W G Kirchoffer, 22 N Carroll St, Madison, consulting engineer.

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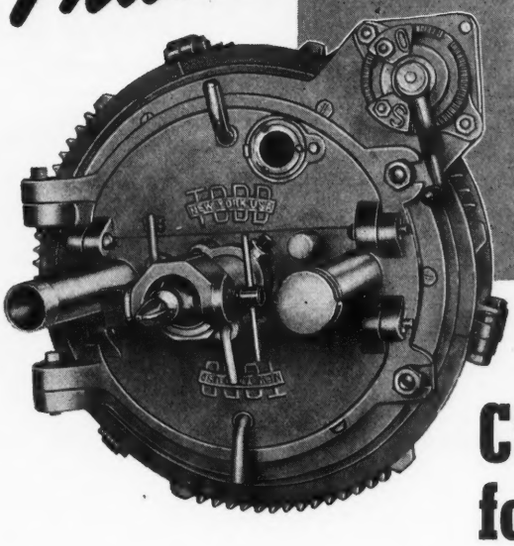
TODD



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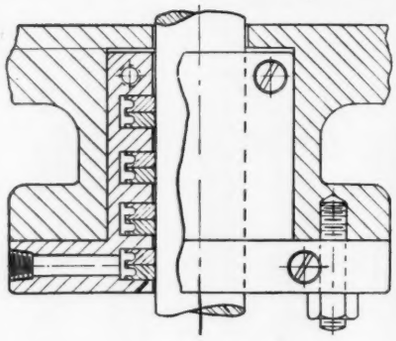

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New Bulletins

BOILERS AND ACCESSORIES

1 BOILER CONTROL—McDonnell & Miller, Wrigley Bldg., Chicago, Ill. 22-page illustrated catalog covers boiler-feed controls and low-water cutoffs. Includes description of methods used to install new controls.

2 STEAM TRAPS—Yarnall-Waring Co, Chestnut Hill, Philadelphia, Pa. 12-page bulletin No. T-1734 describes Yarway impulse steam trap. Advantages, operation, and capacities given, with dimensions and materials used in construction. Typical installations shown.

3 TUBE EXPANDERS—Gustav Wiedeke Co, Dayton, Ohio. 8-page bulletin No. 65 illustrates and describes Series No. 1500 to No. 2600 "Ideal" self-feed expanders to roll and flare drum, header and well tubes in modern steam boilers. Includes illustrations of suitable equipment to operate expanders in small headers and cross-sectional drawings.

4 REFRACTORIES—Quigley Company Inc, 56 W 45th St, New York, N. Y. 20-page catalog form H G 501-50M describes "Hytempite", plastic air-setting, high-temperature cement. Description of cement given, and Uses explained. Industrial applications listed and other products of company described.

5 FEEDWATER HEATERS — Swartwout Co, Cleveland, Ohio. 6-page bulletin No. 5-18-D covers advantages, principles of operation and construction. Typical applications listed, together with other company products.

HEATING AND REFRIGERATION

6 AIR CONDITIONING—Trane Company, La Crosse, Wis. Vol. 2, No. 2 Trane "Weather Magic" bulletin contains stories of typical applications of air-conditioning equipment. Includes "What to Do Before You Pray For Snow", "How to Make Cooling Water Do Double Duty", "Case of the Elegant Elk", and describes other Trane equipment.

7 FANS—Buffalo Forge Company, Buffalo, N. Y. 16-page bulletin 3099 describes limit-load conoidal fans, and silent floating bases. Construction details, performance data, dimensions and standard arrangements are given.

8 EVAPORATIVE CONDENSERS—Buffalo Forge Co, Buffalo, N. Y. 12-page Bulletin No. 505 covers construction, dimensions and arrangements of Type ECC evaporative condensers for Freon and methyl chloride. Piping connections are also shown.

MATERIALS HANDLING

9 AUTOMATIC STORAGE CONTROL—Stephens-Adamson Mfg Co, Aurora, Ill. Bulletin No. 238 describes device that controls level of material in any bin. Operation is normally automatic. Illustrations show installations and wiring diagrams.

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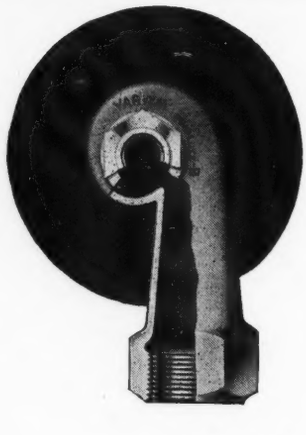

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